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PACKAGING OF MATERIEL
PRESERVATION
(VOLUME I)

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DEPARTMENTS OF THE ARMY, THE NAVY, AND THE AIR FORCE
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3-3 through 3-10	3-3 through 3-10.2
3-25 and 3-26	3-25 and 3-26
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(VOLUME I)

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CHAPTER 1

CLEANING AND DRYING

1-1. Basic Cleaning Principles

a. *Importance of Cleaning*. The success of preservation and packaging operations depends upon the cleaning of items by approved processes. A preservative film will not protect an item if the surfaces are dirty or are covered with corrosion-producing particles. Inadequate cleaning makes all succeeding operations ineffective.

b. *Contamination of Items*. When surfaces of items are dirty or are covered with substances that are not part of the items, they are contaminated. Every manufactured item is subjected to many kinds of contamination from the time it is produced until it is received by the user. Examples of contaminants are drawing, milling, or cooling compounds, metal shavings, chips, abrasives, shop dirt, or corrosion products that form during various steps in manufacture.

c. *Types of Contaminants (fig. 1-1)*. Contaminants are classified into four categories—

(1) Water and water-soluble contaminants, such as heat treat salts, welding fluxes, soldering cleansers, chalk, fingerprints, and perspiration, which must be removed with water.

(2) Solvent-soluble contaminants such as oils, greases, soaps, and cutting and drawing compounds which must be removed with solvents other than water.

(3) Loosely adhering insoluble contaminants such as solid dirt particles, abrasive grains, metal chips, and filings which can be rinsed off with water or solvent.

(4) Tightly adhering insoluble contaminants such as mill and heat scale, carbon deposits, rust, and other corrosion products which cannot be removed except by mechanical means (para 1-4*a*).

d. *Effects of Contaminants*. Contaminants affect the surfaces of items in varying ways. Many contaminants are corrosive; others are hygroscopic (they absorb moisture) and promote corrosion. Some contaminants prevent adequate adhesion of an applied coating. Solid contaminants interfere with an applied protective film and provide points of entry for water or other corrosive agents. All of these properties of contaminants tend to cause items to corrode, since corrosion may occur on certain metals whenever any of the following conditions exist:

(1) A metal (the item) plus oxygen and water.

(2) A metal (the item) plus acids or alkalies and water.

(3) A metal (the item) plus salts and water.

(4) A metal (the item) plus a different metal and water.

(5) A metal (the item) plus corrosive gases or vapors and water.

Note that water in any form is the common factor in all four situations.

e. *Contaminant Removal*. Removal of contaminants depends upon the composition, degree of criticalness, and complexity of the item, and upon the type of contaminant present. Contaminants are not all affected the same way by a given solvent. For instance, a cleaner that is suitable for removing oil-soluble contaminants may not be capable of removing rust and scale. Likewise, a cleaner that is suitable for removing rust and scale may not remove fingerprints and other water-soluble contaminants. Oil-soluble or easily emulsified contaminants can be removed either by solvents or water-emulsion solutions. Highly finished items contaminated with perspiration, fingerprints, and oil-soluble contaminants require a combination of cleaners to insure the removal of the fingerprints and per-

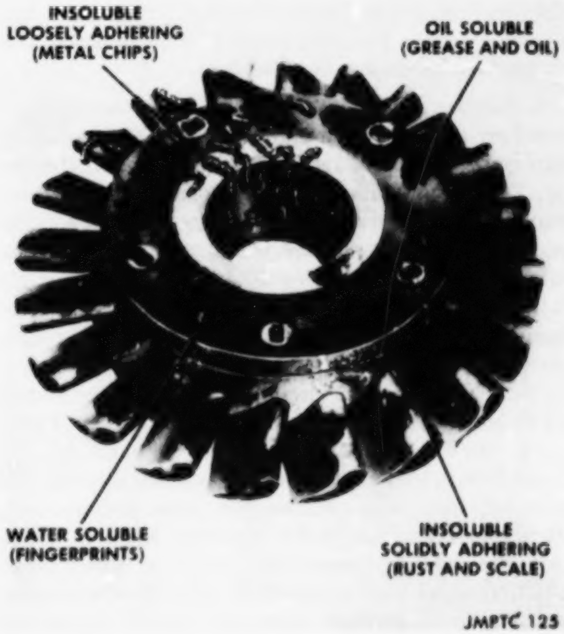


Figure 1-1. Types of contaminants.

spiration. A cleaning process or combination of processes should be chosen that will remove all contaminants.

1-2. Cleaning Requirements

Basic cleaning requirements are listed in Specification MIL-P-116. The cleaning must be thorough and cause no injury to the item. Disassembly must be held to a practicable minimum. Fingerprints and perspiration must be removed from all critical surfaces. Items must pass the prescribed cleanliness tests (para 1-14) (fig 1-2).

1-3. Selecting a Cleaning Process

The selection of a cleaning process depends upon the characteristics of the item, the nature of the contaminants, availability of cleaning materials and equipment, and the safety hazards involved.

a. Composition of the Item. The composition of the item limits the choice of the cleaning process. Aluminum or zinc items should not be cleaned in highly alkaline cleaners because of detrimental effect of the cleaner. Nonmetallic items of rubber, fabric, cork, or other organic composition should not be cleaned haphazardly in organic or water-soluble alkaline cleaners. If solvent cleaning is applied to such items, the solvent exposure must be brief and scrubbing action limited when dimensions and use conditions of the item are critical. Petroleum solvents are detrimental to most rubber and synthetic rubber materials. If metallic and nonmetallic materials are combined in an assembly, the cleaning process must be carefully considered and the choice of the process governed by the nature of the materials combined in the assembly.

b. Surface Finish of the Item. Some cleaning processes are safe to use on highly finished and precision surfaces while other processes are likely to mar the finish. For instance, alkaline cleaning should not be used on polished aluminum. Acid cleaners are used on iron and steel with extreme care. For most critical surfaces of metal items, the petroleum solvent (para 1-5) or vapor degreasing (para 1-6) processes usually are recommended. Surfaces of rough forgings or casting, rough ground or rough machined items, or surfaces having no finishing after stamping or drawings, are cleaned by alkaline cleaning processes. Items with porous surfaces, small crevices, or with capillary holes are not cleaned with alkaline cleaning processes because the complete removal of all residues is not possible and corrosion will result. This is also true of items which have extended lap joints, riveted areas, spot-welded additions, and similar constructions. Porous, oil-impregnated, or graphite lubricated items should be cleaned by wiping with a dry cloth. Items with porcelain or painted surfaces are not cleaned in strong alkaline solution. Solvent cleaning cannot be applied indiscriminately to painted surfaces; however, zinc-chromated primers, exterior paints, lacquers, and enamels are usually handled safely in petroleum solvent cleaners.

c. Complexity of the Item. Items having irregular surfaces, crevices, undercuts, and pockets that could trap the cleaning fluids may only be cleaned by brushing or wiping when solvent cleaning is employed. Clean complex assemblies prior to assembly. Such assemblies as electric generators, motors, starters, gauges, meters, timing devices, and other complex units should be cleaned before assembly and kept clean thereafter.

d. Availability of Facilities. Approved materials and equipment should be used wherever possible. If the desired cleaning materials and equipment are not available, consider carefully the selection of an alternate process. Solvent cleaning can be done in pails, buckets, drums, or barrels in an emergency. This is also true to some extent with the alkaline cleaners. The hot vapor degreasing process requires specially designed equipment, but the solvents used for vapor degreasing can be used cold if due caution is taken to avoid overexposure to the vapors. Most cleaning processes are not too complex, and operations can be modified to meet the needs of the situation.

e. Health and Safety Hazards. All cleaning processes have health and safety hazards that must be recognized. These cleaning processes must comply with the requirements of the Occupational Safety and Health Act (OSHA) of 1970, or Executive Order 11612, as applicable. Vapor degreasing demands special care because the vapor from the degreaser is toxic and may cause injury to the lungs and skin. Solvent cleaning materials may be flammable and present a safety hazard; in addition, they may cause skin irritations or nausea if the vapor concentration gets too high. Special equipment and sufficient ventilation are required for such solvents. Water base cleaners usually are heated and may result in burns and rashes. All these materials, however, are widely used and few ill effect occur when potential dangers are recognized and care is taken to avoid them.

1-4. Any Applicable Process (Process C-1)

Process C-1 can be used, first, when required by a specification or a contract, and second, when Military Specification MIL-P-116 is cited as the cleaning guide without reference to any specific process. Any process or combination of processes which will accomplish thorough cleaning without damage to the item will be appropriate. If a specific process cannot be cited, then cleaning by C-1 is in order. Cleaning processes are either mechanical or chemical.

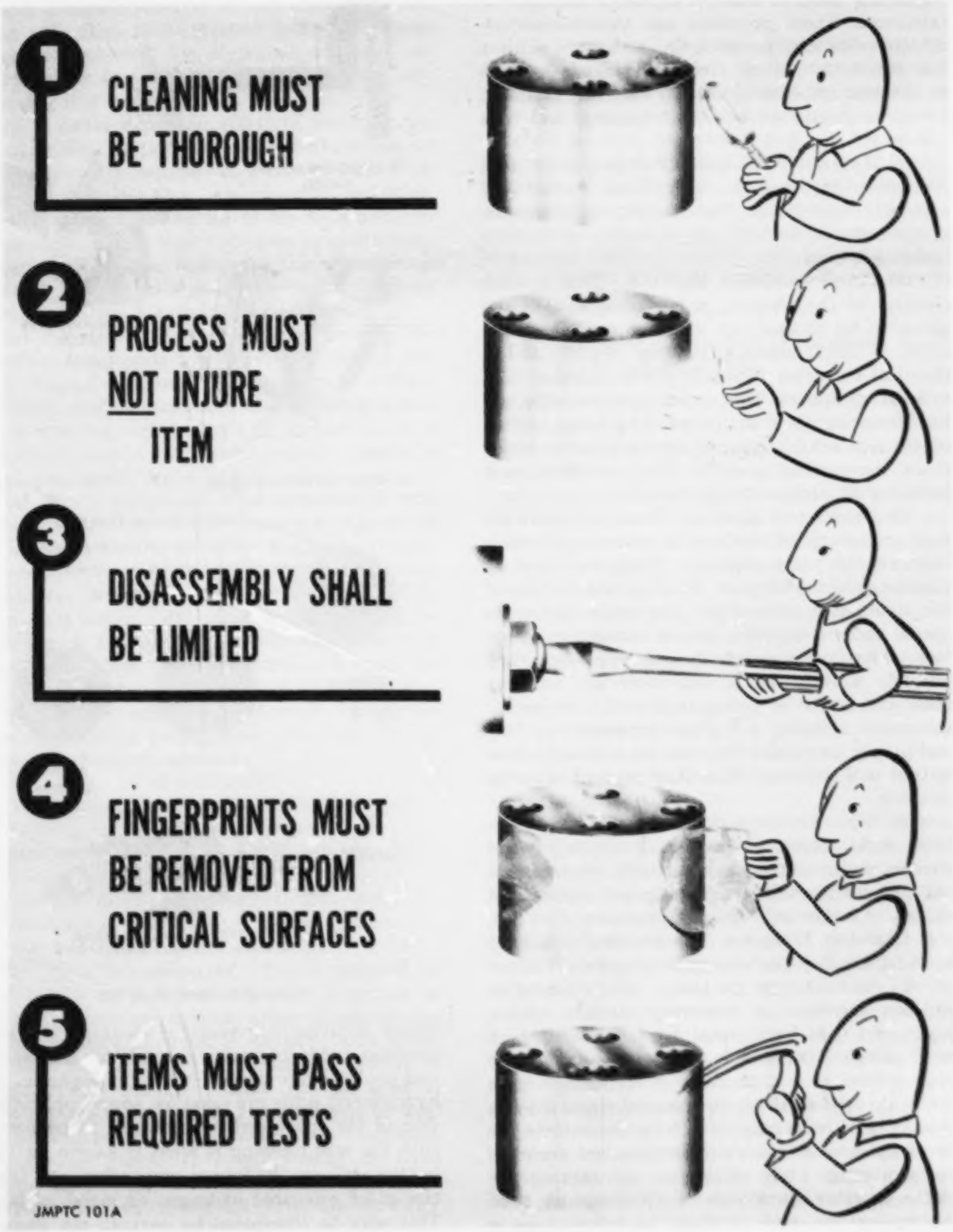

1
CLEANING MUST BE THOROUGH
2
PROCESS MUST NOT INJURE ITEM
3
DISASSEMBLY SHALL BE LIMITED
4
FINGERPRINTS MUST BE REMOVED FROM CRITICAL SURFACES
5
ITEMS MUST PASS REQUIRED TESTS
JMPTC 101A

Figure 1-2. Cleaning requirements.

a. Mechanical Processes. The mechanical processes are used to remove tightly adhering contaminants. These processes use abrasive materials, pressure and power tools, and often subject the items to severe treatment. Some of the mechanical processes are: air-vacuum cleaning, barrel tumbling, impact tool cleaning, and wire brushing.

(1) *Air-vacuum cleaning.* This process is used to remove dust and lint from items during final assembly operations. The cleaning of electronic components is an example in which air-vacuum cleaning is used.

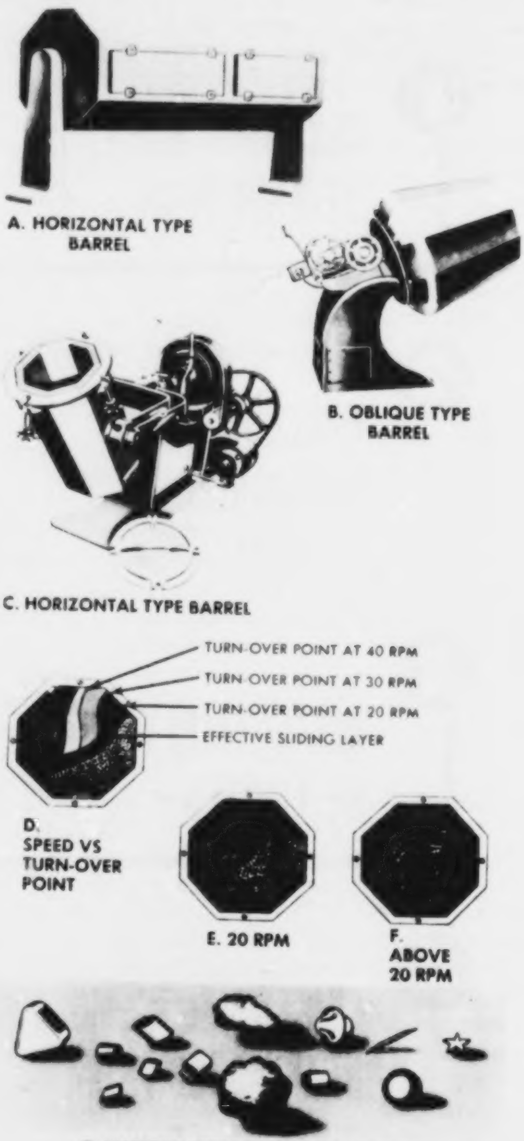
(2) *Barrel tumbling (fig. 1-3).* This process consists of the cleaning mass, composed of the items to be cleaned, an abrasive or rolling medium, a fluid lubricant (usually water), and a chemical corrosion inhibitor mixed together in a cylinder or barrel. This cleaning mass rolls and tumbles upon itself in the barrel by being carried up the side until it reaches a point where it slides down because of gravity, thus scrubbing and polishing all surfaces to be cleaned.

(3) *Impact tool cleaning.* These processes are used on noncritical surfaces to remove mill scale, rust, or old paint coatings. They are done by pounding, hammering, or chiseling the surface of the item with manual or pneumatic hammers, chisel, scalers, scrapers, rotary wheels, or vibrators. Wherever these tools are employed, they must be suitably sharp. Dull tools tend to drive scale and corrosion products into the surface of the metal, creating a nucleus for corrosion. Oily and greasy contaminants must be removed before impact tool cleaning, since they prevent effective cleaning.

(4) *Wire brushing.* Wire brushing removes loose scale, corrosion products, old paint, and similar encrustations from metallic surfaces. It will not remove tightly-adhering mill scale, tight oxides, or embedded corrosion products.

b. Chemical Processes. The chemical processes are acid, alkaline, and detergent cleaning.

(1) *Acid cleaning (pickling).* Acid cleaning or pickling consists of removing surface oxides, scale, and rust from metal by immersion in an acid solution. Oil-soluble contaminants must be removed before acid cleaning. After immersion in the acid solution, the item is rinsed thoroughly to remove any remaining acid from its surface. In some operations, the acid residues are removed by scrubbing, while rinsing or neutralizing the items. In other operations, an alkaline rinse, used to remove the acid residues, is followed by a chromate or phosphoric-chromic acid rinse to neutralize the alkali and retard corrosion. In all cases, the surfaces of the item must be neutral before applying a protective coating. The most common types of pickling solutions are sulfuric and hydrochloric acids. Nitric, phosphoric, and hydrofluoric acids are used for some applications. One of the most serious problems in connection with the acid cleaning is what is known as "acid brittleness" or "hydrogen embrittlement" (Penetration of generated hydrogen on metal surfaces). This may be eliminated by soaking the items in boiling water immediately after pickling, or may be minimized by the use of the proper inhibitor. Water rinsing is a very important operation after


A. HORIZONTAL TYPE BARREL
B. OBLIQUE TYPE BARREL
C. HORIZONTAL TYPE BARREL
TURN-OVER POINT AT 40 RPM
TURN-OVER POINT AT 30 RPM
TURN-OVER POINT AT 20 RPM
EFFECTIVE SLIDING LAYER
D. SPEED VS TURN-OVER POINT
E. 20 RPM
F. ABOVE 20 RPM
G. VARIOUS TYPES OF ROLLING MEDIA

JMPTC 651

Figure 1-3. Barrel tumbling.

pickling to remove all traces of acid and iron salts. If complete removal of such residues by the water rinse alone is doubtful or if the parts must remain unprotected for a period of time, an alkaline rinse is recommended to neutralize any remaining acid residues.

(2) *Alkaline derusting.* Alkaline derusting, using an immersion process with either electrolytic or nonelectrolytic equipment, removes rust from steel objects better than acid cleaning, and without affecting the dimensions of the base metal in the process. Much less hydrogen embrittlement (entrapped hydrogen bubbles within the porous structure of the metal and rerusting of the base metal occur when alkaline derusting is used.

(*a*) *Alkaline derusting compounds.* The derusting compounds (MIL-C-14460) are of two types. Type I compound is a mixture of sodium hydroxide, sodium gluconate, a complexing agent, and a foaming agent. Type II compound is a mixture of sodium hydroxide, sodium cyanide, a complexing agent, and a foaming agent.

(*b*) *Type I compound.* This compound is used for rust removal by simple immersion of items in the heated derusting solution. The usual concentration of this compound is 5 pounds per gallon of solution. It may be used for cleaning copper, brass, magnesium, and other metals as well as remove rust and scale from bare or coated iron and steel surfaces. If type I material is used, the solution is heated to boiling. A "rolling". boil gives effective agitation. Thorough rinsing in clean water with prompt and thorough drying follows all treatments.

WARNING

This material causes burns to skin and eyes. Wear goggles or face shield when handling. Avoid dust and fumes. Keep away from food products. In case of contact flush skin and affected parts thoroughly with water. Take no chances. Get immediate medical attention!

(*c*) *Type II compound.* This compound is used for the most severe conditions of rusting on exterior or interior surfaces where equipment for electro-cleaning is available. Usually, it is mixed at the rate of 2 or 3 pounds per gallon of solution. This material should not be used at temperatures above 130°F. It should not be used for cleaning potable water tanks, food containers, and similar items. Thorough rinsing in clean water, followed by thorough drying, should accompany cleaning operations with this material.

WARNING

This compound contains sodium cyanide! Do not mix or allow to come in contact with acids or acid solutions. Contact with acid liberates poisonous cyanide gas! Keep container closed and in a dry place. Poison!

(3) *Detergent cleaning.* Detergent material (MIL-D-16791) is used for removing contaminants from a vast range of items such as rubber, plastics, canvas, and metallic materials. The detergent usually is used with a 1.2-percent isopropyl alcohol addition. The detergent is dissolved in either fresh water or sea water and will efficiently remove grease, oil, and dirt from a wide variety of surfaces. Water-emulsion cleaning compound (MIL-C-43616) can be used where MIL-D-16791 material is used and will remove heavier contaminants.

1-5. Solvent Cleaning (Processes C-3, C-5, and C-8)

Solvent cleaning makes use of several solvents, utilizing processes known as C-3, Solvent Cleaning, C-8, Fingerprint Removal, and C-5, which is a combination of C-3 followed by C-8.

a. Applicability of the Processes. The solvent cleaning processes are used to remove oils and greases remaining after machining, milling, polishing, and similar operations; or any time the item is contaminated with oil-soluble contaminants. Solvent cleaning with pressure spray equipment removes loose chips and other loosely adhering particles produced during fabrication of the item. Solvent cleaning is used when the only contaminant is a light grease or oil. The spraying process is used on items of simple construction with surfaces that can be reached by the solvent spray. Solvent cleaning will not remove rust or corrosion products.

b. Materials for Solvent Cleaning. Solvent cleaning materials are: drycleaning solvent, paint thinner, corrosion preventive fingerprint remover compound, tetrachloroethylene, trichloroethylene, and trichloroethane (methyl chloroform).

(1) *Drycleaning solvent (P-D-680).* This is a water-clear liquid that is neutral to metals and only slightly irritating to the skin. It may be mildly nauseating when excessive vapors are breathed. It evaporates quickly without leaving a corrosion inducing film on metal surfaces. It is used especially for removing oils and greases from metal surfaces by brushing, wiping, spraying, or immersion. Drycleaning solvent has a flashpoint (the point at which there are sufficient vapors from the solvent to ignite in the presence of a flame or spark) of 100°F., or higher. The material must be used only at room tempeature, since heating increases greatly the fire hazard. *Warning: Keep solvent away from any open flame or source of sparks!*

(2) *Volatile mineral spirits, paint thinner (TT-T-291).* Paint thinner is supplied as two grades of petroleum distillate. Only grade I (light thinner) is used for petroleum solvent cleaning as specified in Specification MIL-P-116. It is an excellent solvent for oils and greases. It is similar to dry cleaning solvent (P-D-680), having the same flashpoint and degree of toxicity, but is more highly refined and is usually higher priced.

(3) *Fingerprint remover corrosion preventive compound (MIL-C-15074).* This is a homogeneous, stable mixture of solvent, soap, and water. It is capable of removing water soluble contaminants such as fingerprints, suppressing perspiration corrosion, and temporarily protecting steel surfaces. It is nontoxic and free from disagreeable or offensive odors.

(4) *Technical trichloroethylene (O-T-634).* Type I trichloroethylene is intended for use in drycleaning and for general solvent purposes. Type II trichloroethylene is intended for vapor degreasing of metals. This is clear, nonflammable solvent for oil-soluble contaminants. It may be used either in its liquid state or, as a result of heating, in vapor form in which form it has a chloroform-like odor. The breathing of the vapor can become habit forming because of the intoxicating or exhilarating effects resulting from inhaling the fumes. Type II, with a boiling point of 188°F. is specially procured for vapor degreasing. Trichloroethylene will not remove fingerprints, rust, scale, and other insoluble contaminants. It does not mix readily with water. It is 1½ times heavier than water, making water separation rather simple. It is nonexplosive at ordinary working temperatures. The low boiling point makes it an economical solvent to use. Its vapor is 4½ times heavier than air. This tends to keep the vapor confined even in an uncovered cleaning chamber.

WARNING

Use only with adequate ventilation. Vapors in high concentrations are anesthetic and dangerous to life. Signs of high concentrations are eye irritation and dizziness. Avoid prolonged breathing of vapor. Avoid prolonged or repeated contact with skin. Do not take internally. Contact with flames or hot glowing surfaces may form corrosive acid fumes.

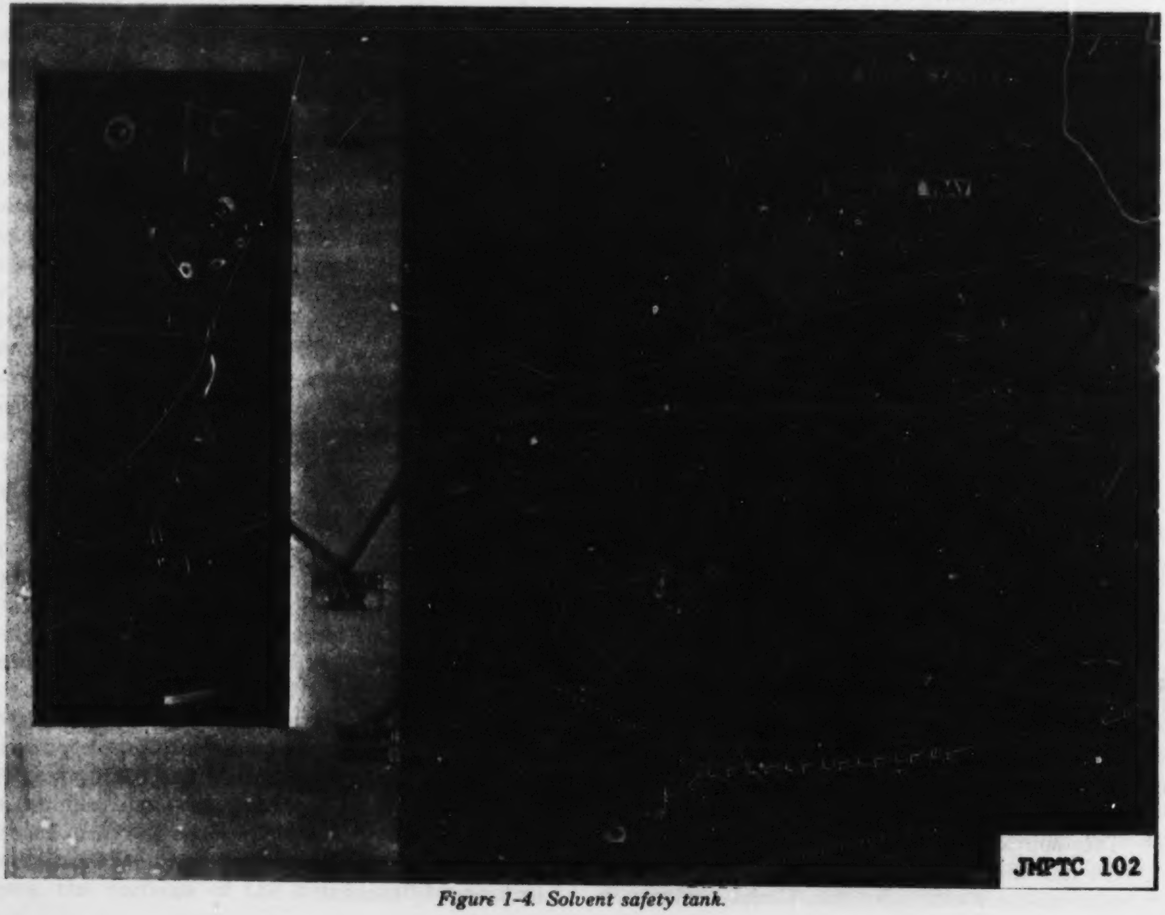


Figure 1-4. Solvent safety tank.

(5) *Technical tetrachloroethylene (perchloroethylene) (O-T-236).* Tetrachloroethylene is similar to trichloroethylene. Its differences make it the preferred solvent in some situations. It is completely insoluble in water. Any water that condenses in the degreaser at night is soon evaporated to steam before the solvent reaches its boiling point (250°F). This high boiling point also permits a longer cleaning cycle than possible with trichloroethylene because of the longer time required to reach temperature equilibrium. The vapor of tetrachloroethylene is six times heavier than air, thus restricting the loss of vapor. This permits construction of portable, air-cooled degreasers. Tetrachloroethylene is less toxic than trichloroethylene, but it must be handled with reasonable care. Strong vapor concentrations will result in symptoms similar to those caused by trichloroethylene. Tetrachloroethylene is more stable and requires no stablizers. It is nonflammable and will only decompose at extremely high temperatures. Like trichloroethylene, it does not remove fingerprints, rust, or scale.

(6) *Technical inhibitive trichloroethane (methyl chloroform) (O-T-620).* The material covered by this specification shall be of one grade and three types: Type I, Regular; Type II, with Dauber; Type III, Aerosol. Type I material is intended as a solvent for cleaning operations and for cleaning and degreasing electrical equipment. Type II material is intended for removing residue from type faces of typewriters. Type III material is intended for cleaning assembled electronic equipment. Care should be exercised when used on synthetic materials as it may affect certain synthetic products. Each container is prominently labeled with instructions that must be strictly observed.

(7) *Inhibited trichloroethane (methyl chloroform) (MIL-T-81533).* The material covered by this specification is intended for use where air pollution regulations preclude the use of other materials. Each container is marked with instructions that must be strictly observed.

c. *Equipment Used in Solvent Cleaning.* The equipment required for solvent cleaning includes petroleum solvent tanks, portable solvent degreasers, and solvent spray washers.

(1) *Solvent tanks (fig 1-4).* Solvent tanks are simply constructed, but must be capable of holding the solvent. Where cleaning is conducted at an established installation, special safety features are required in the tank design. Tanks are constructed of low-carbon steel and are welded at the seams. A typical solvent tank with safety features consists of a rectangular compartment, with a tight fitting cover held open during cleaning operations by means of a chain containing a fusible link. This is held together by a low-melting solder. Should the solvent catch fire, the heat evolved melts the solder and allows the lid to close and smother the fire. For this reason, it is important that the fusible link should always be in an operable condition. The lid should never be wired or fastened so that it cannot close automatically in case of fire. Tanks must be provided with a ground connection to carry off any static charges of electricity.

(2) *Tank immersion solvent degreasers (MIL-D-12491).* These electrically-operated cleaning machines (fig 1-5) are furnished in 20- to 80-gallon sizes. Each machine consists of a sheet metal tank mounted on a wheeled frame, and fitted with a hinged cover. The firestop designed cover is held open by an automatic releasing fusible link. These degreasers are provided with removable shelves located low enough to minimize splashing. Each degreaser has a removable grille and a wire basket. The basket is supported on the grille while items are sprayed with solvent. A pump driven by an explosion-proof motor pumps the solvent through the spray nozzle. Other types of solvent spray cleaners are shown in figure 1-6.

(3) *Improvised tanks.* In the absence of approved cleaning equipment, solvent cleaning can be done in drums, pails, cans, or other containers. Fifty-five-gallon drums split in half make suitable tanks for field expedience. Regardless of the container used, provision must be made to keep it closed when not in use.

d. *Safety Precautions of Solvent Cleaning.* When not in use, covers must be kept in place on all solvent tanks. To prevent the accumulation of flammable vapor and the build up of an explosive mixture, adequate ventilation must be provided, especially if paint thinner is used. Carbon dioxide fire extinguishers must be located in the vicinity, and personnel trained in their use. A fire blanket should be located nearby. Solvents remove natural oils and may cause skin irritations. Some people are susceptible to the solvent and are afflicted with blisters and chapped skin upon exposure. Operators should wear oil-resistant rubber or plastic gloves and work aprons during cleaning operations to protect themselves and to keep the items free from fingerprints (fig 1-7). High vapor concentrations of these solvents may cause dizziness, fainting, and nausea, if breathed.

e. *Solvent Cleaning by Immersion (Process C-3) (fig 1-8).* The solvent cleaning immersion operations are as follows (fig 1-9).

(1) Wear safety goggles, rubber gloves, and apron.

(2) Immerse items in solvent.

(3) Agitate items thoroughly. Position items to receive the most effective washing action.

(4) Use a brush where necessary to remove dirt.

(5) Remove items from tank when visually clean.

(6) Drain completely, allowing excess solvent to return to tank.

(7) Immerse items in a second tank of clean solvent.

(8) Agitate as necessary.

(9) Place items on tray to drain.

(10) Apply appropriate cleanliness tests (para 1-14).

f. Solvent Cleaning by Scrubbing and Wiping. When cleaning items that are too large for available cleaning tanks, or because it is impractical to clean by immersion or spraying, the sequence of operations (fig 1-10) is—

(1) Wear safety goggles, rubber gloves, and apron.

(2) Soak cleaning cloth or brush in clean solvent.

(3) Apply cleaning cloth or brush in clean solvent.

(4) Use a combination of soaking, scrubbing, and wiping as necessary.

(5) Rinse off area with a clean cloth soaked in clean solvent. Flush over cleaned area and rinse.

(6) Drain, shake, or wipe off excess solvent.

(7) Apply appropriate cleaning tests (para 1-14).

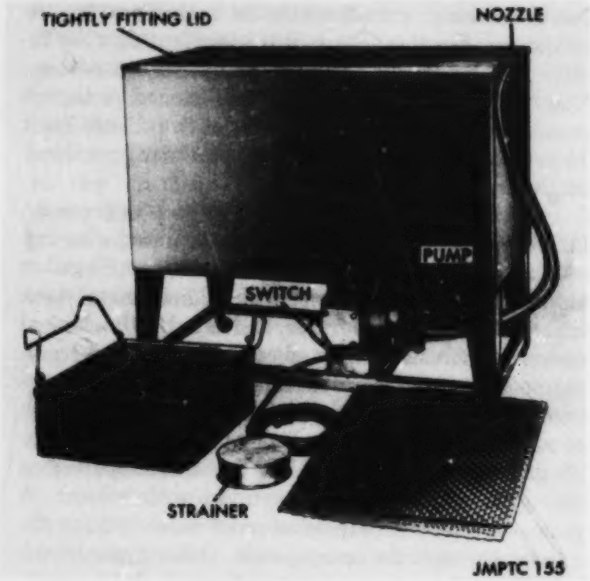

TIGHTLY FITTING LID
NOZZLE
PUMP
SWITCH
STRAINER
JMPTC 155

Figure 1-5. Portable solvent degreaser.

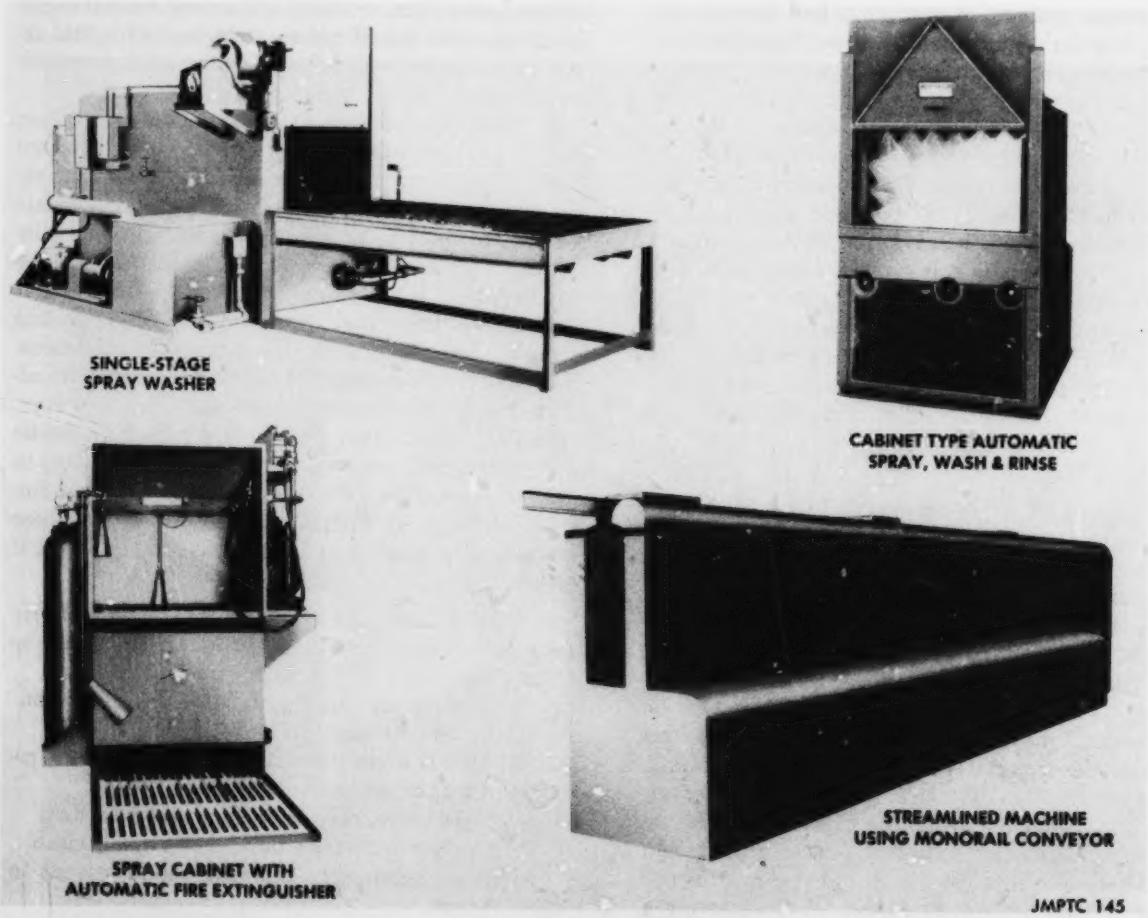

SINGLE-STAGE SPRAY WASHER
CABINET TYPE AUTOMATIC SPRAY, WASH & RINSE
SPRAY CABINET WITH AUTOMATIC FIRE EXTINGUISHER
STREAMLINED MACHINE USING MONORAIL CONVEYOR
JMPTC 145

Figure 1-6. Solvent spray cleaners.

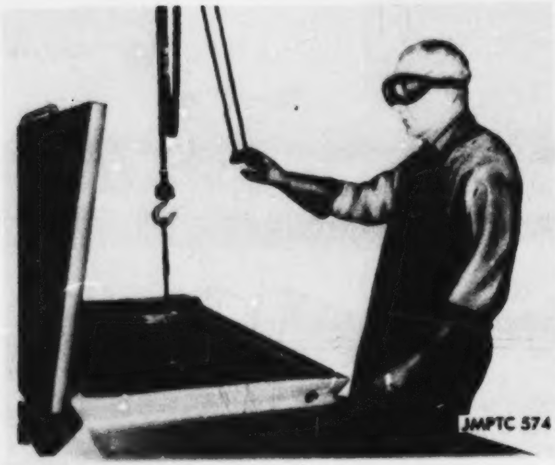


Figure 1-7. Solvent safety clothing.

g. Solvent Cleaning by Spraying. If items are of simple construction, free of cavities and indentations, and the equipment is available, the solvent spraying steps (fig 1-11) are—

(1) Wear rubber gloves, goggles, and apron.
(2) Load items into solvent spray area.
(3) Turn on spray pump and direct nozzle at items.
(4) Shift items in basket so spray reaches all areas.
(5) Remove items from spray zone and permit to drain.
(6) Apply appropriate cleaning tests (para 1-14).

h. Perspiration and Fingerprint Removal (Process C-8) (fig 1-12). All items with critical functioning surfaces or with close tolerances must be cleaned in perspiration and fingerprint remover until they will pass the cleaning tests of Specification MIL-P-116 (para 1-14). Items are treated for fingerprint removal (fig 1-13) by the following steps:

(1) Wear safety goggles, rubber gloves, and apron.
(2) Immerse items in perspiration and fingerprint removal compound.
(3) Agitate items for a minimum of 2 minutes.
(4) If item is too large for complete immersion, clean critical surfaces with a lint free clean cloth saturated in fingerprint remover.
(5) After the petroleum base fingerprint remover (MIL-C-15074) is used, rinse items in a second tank containing clean solvent conforming to O-T-620, O-T-236, TT-T-291 (grade 1), O-T-634, P-D-680 or MIL-T-81533, to remove the fingerprint residue.

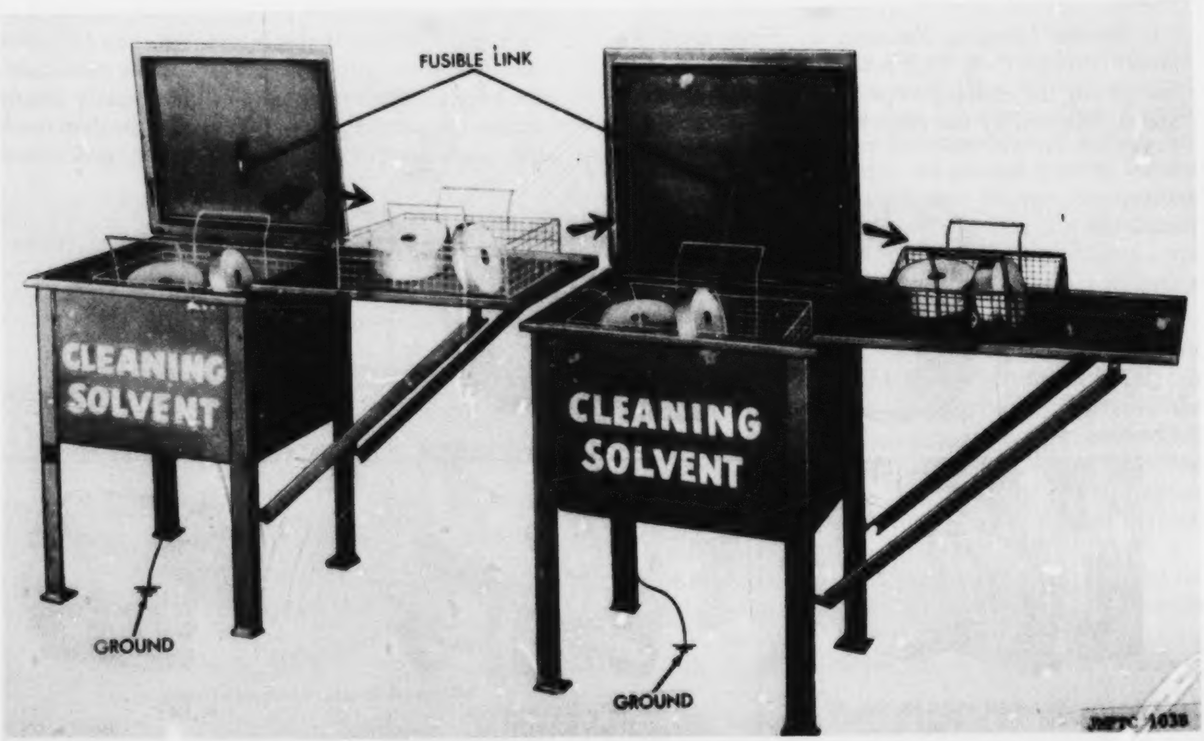


Figure 1-8. Process C-3, solvent cleaning by immersion.

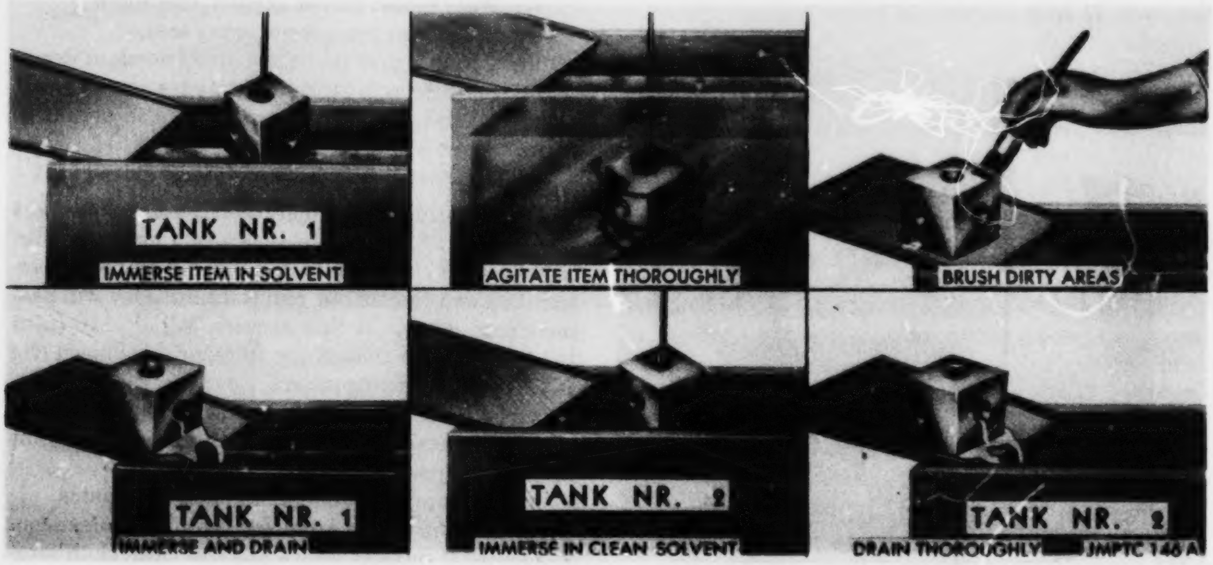

TANK NR. 1
IMMERSE ITEM IN SOLVENT
AGITATE ITEM THOROUGHLY
BRUSH DIRTY AREAS
TANK NR. 1
IMMERSE AND DRAIN
TANK NR. 2
IMMERSE IN CLEAN SOLVENT
TANK NR. 2
DRAIN THOROUGHLY
JMPTC 146 A

Figure 1-9. Solvent immersion operations.

(6) Agitate items in rinse solvent for at least 1 minute.

(7) After rinsing, drain items thoroughly.

(8) Apply appropriate cleanliness tests (para 1-14).

i. Solvent Cleaning Followed by Fingerprint Remover (Process C-5). This process is accomplished by completing the cleaning steps described in *c* through *g* above, followed by the steps outlined in *h* above (fig 1-14).

1-6. Vapor Degreasing (Process C-7)

a. The Principles of Vapor Degreasing (fig 1-15). Vapor degreasing is used for the rapid and thorough removal of heavy oils and greases from most metal products. It utilizes the vapor of special grades of nonflammable, chlorinated solvents. When an oily, greasy item is lowered into the vapor, the vapor condenses on the item and the resulting hot liquid rapidly dissolves and rinses away the contaminants. As the item reaches the same temperature of the vapor, condensation

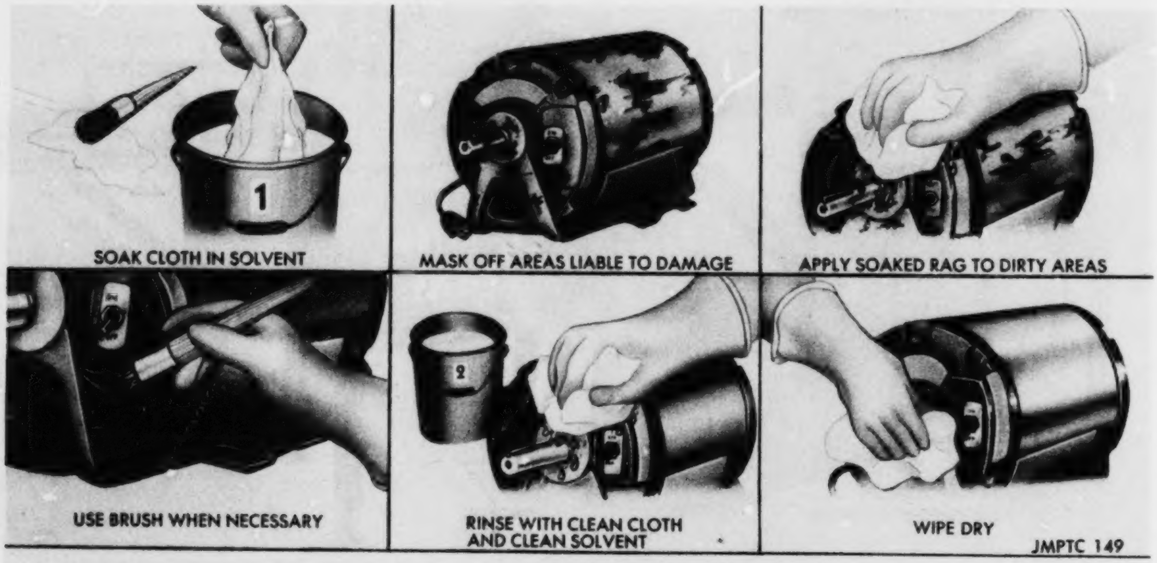

1
SOAK CLOTH IN SOLVENT
MASK OFF AREAS LIABLE TO DAMAGE
APPLY SOAKED RAG TO DIRTY AREAS
USE BRUSH WHEN NECESSARY
2
RINSE WITH CLEAN CLOTH AND CLEAN SOLVENT
WIPE DRY
JMPTC 149

Figure 1-10. Process C-3, solvent scrubbing and wiping.

ceases and cleaning stops. The degreasing process is quite simple, but must be performed only in specially designed equipment because of the health hazard involved. Operating rules as outlined in manufacturers' manuals must be strictly followed.

b. Applicability of Vapor Degreasing. This process is used whenever the temperatures involved will not result in damage, injury, or malfunction of the item. Vapor degreasing is extensively used because of the ease and rapidity of removal of oils and greases from metal items of simple construction. The items are clean, dry, and ready for preservation and packing as soon as removed from the degreaser and allowed to cool. The process is economical, once the equipment is installed, and use is made of solvents that are free from fire hazards.

c. Vapor Degreasing Materials. The materials used for vapor degreasing are products of the chemical industry known as chlorinated solvents (trichloroethylene, tetrachloroethylene or methyl chloroform).

(1) *Technical trichloroethylene (O-T-634, Type II).* (para 1-5*b* (4))

(2) *Technical tetrachloroethylene (perchloroethylene) (O-T-236).* (para 1-5*b* (5))

(3) *Technical inhibited 1, 1, 1, trichloroethane (Methyl chloroform) (O-T-620).* (para 1-5*b* (6))

(4) *Inhibited 1, 1, 1, trichloroethane (Methyl chloroform) vapor degreasing (MIL-T-81533).* (para 1-5*b* (7))

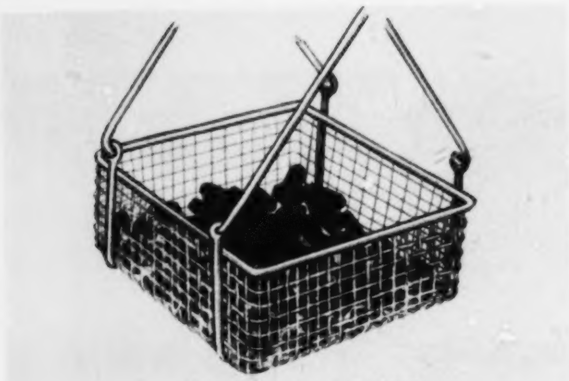
(5) *Restrictions in the use of solvents.* Care shall be taken to assure that when these solvents are used, aluminum surfaces are not adversely affected by depletion of inhibitors or decomposition of solvent. Any cleaning material used in the process must be selected to comply with the Williams Steiger Occupational Safety and Health Act of 1970 and the use thereof shall conform to Air Pollution Control Statutes and regulations in force in the geographic and industrial areas where cleaning is performed.

d. Equipment Used in Vapor Degreasing (fig 1-16). Vapor degreasing should be performed only in properly designed and controlled equipment. The manufacturer's guide to operations must be carefully followed. Degreasers vary greatly in size and complexity, but they all have basic components that are included in all units. A vapor degreaser in its simplest form consists of the following components:

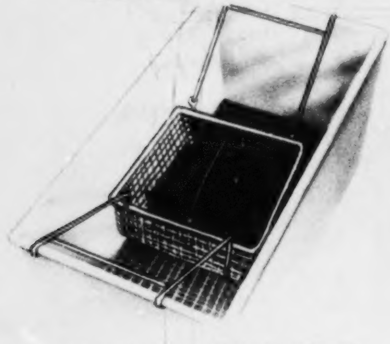
(1) *Heating elements (A).* A source of heat designed to raise the temperature of the solvent to the boiling point.

(2) *Boiling chamber (B).* A tank or vat capable of holding the solvent.

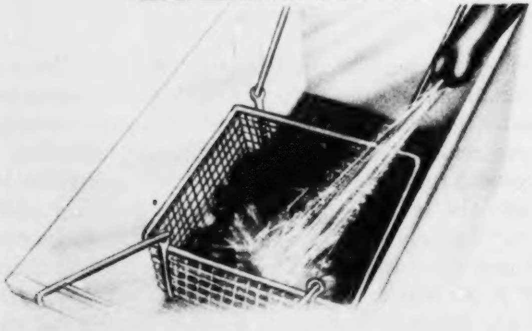
(3) *Vapor area (C).* A work space between the surface of the boiling solvent and the top of the con-



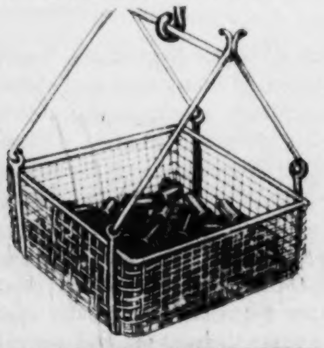
LOAD ITEMS IN WORK BASKET



LOWER BASKET INTO SPRAY TANK



DIRECT NOZZLE AT ITEMS



REMOVE BASKET — ALLOW TO DRAIN

JMPTC 152

Figure 1-11. Process C-3, solvent spray cleaning.

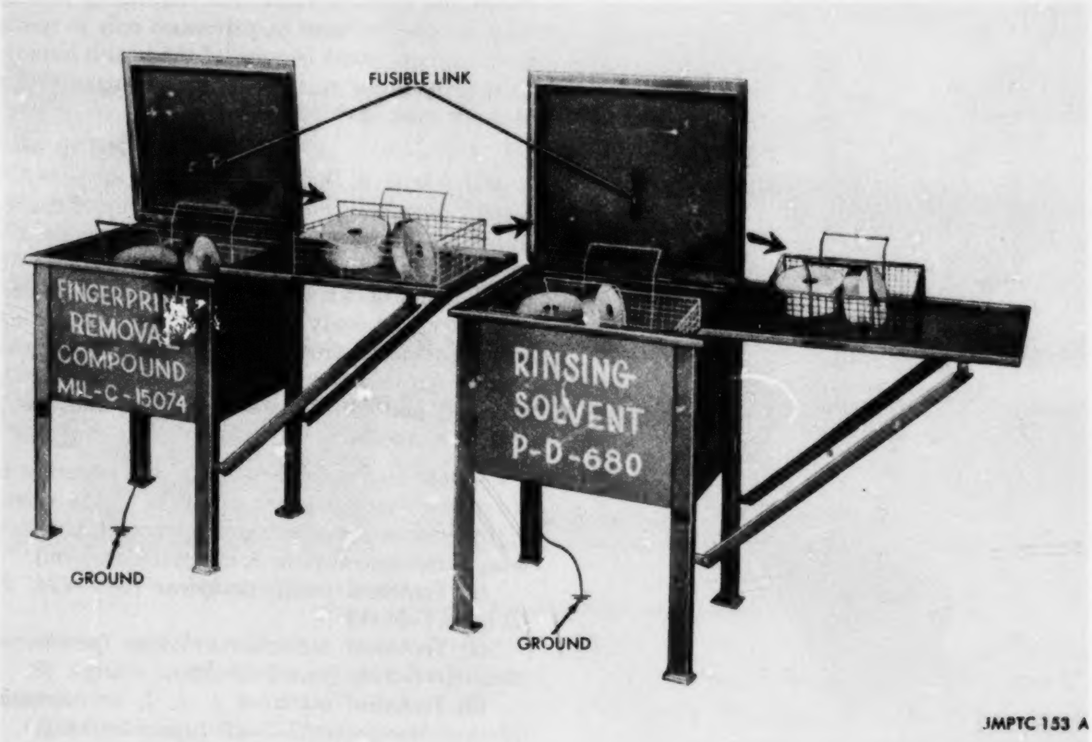


Figure 1-12. Process C-8, perspiration and fingerprint removal.

denser, large enough to hold the vapor and accommodate the work.

(4) *Condenser (D).* The water jacket and coils used to balance the heat input and condense the vapor. (Degreasers designed for tetrachloroethylene only, may be without a condenser. The walls of the tank are correspondingly higher to provide for aircooling.)

(5) *Work clearance space (E).* Additional wall height above the condenser prevents normal air currents from pulling vapor from the degreaser.

(6) *Safety thermostat (F).* This shuts off the heating elements if the vapor should rise above the condenser.

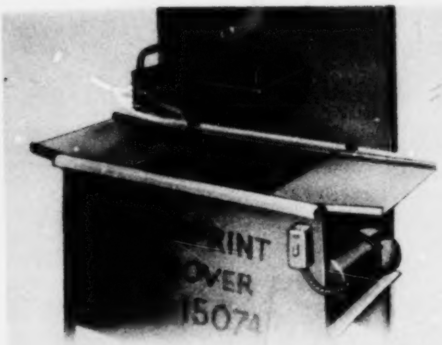
(7) *Drainage trough (G).* This collects the condensed solvents from the walls and delivers them through the water separator to the storage tank or boiling chamber.

(8) *Water separator (H).* This collects moisture, condenses it and separates it from the solvent.

(9) *Clean solvent storage tank (J).* Where the returning solvent can be held or returned to the boiling chamber.

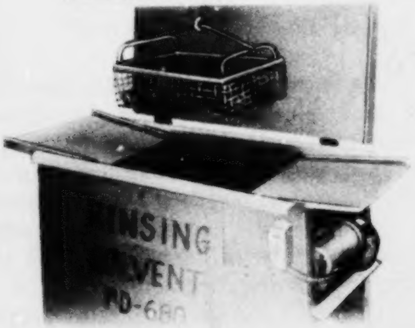
e. Functioning of a Degreaser. The solvent in the boiling chamber (B) is heated by the heating elements (A) until boiling begins and vapor rises into the vapor area (C). As the vapor reaches about midpoint of the condenser (D) it begins condensing along the walls of the degreaser. The condensed solvent then flows into the draining trough (G) and back to the water separator (H) where any moisture in the solvent is trapped and removed as necessary. From the separator, the solvent returns to the clean storage tank (J) or back into the boiling chamber. If the condenser cooling water supply should fail during operations, the rise of vapor above the tank is prevented by a safety thermostat (F) which automatically turns off the heating coils. Another thermostat is often located just above the heating coils to turn the heat on again when the vapor level drops too low.

f. Types of Vapor Degreasers. Vapor degreasers are manufactured in many sizes and shapes, ranging from small, batch-type, manually operated models, to huge, continuous, fully automatic, conveyorized installations. Vapor degreasers may be heated by gas, steam, or electricity. They may be designed for use with trichloroethylene or tetrachloroethylene only, or capable of using either solvent. There are manually operated, water and air-cooled degreasers; manually operated, flush vapor degreasers; manually operated, two- and three-dip vapor degreasers; and several designs of conveyorized vapor degreasers, which incorporate various special features. Several types of vapor degreasers are illustrated in figure 1-17.

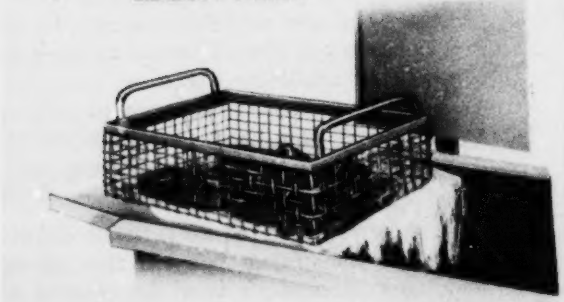


IMMERSE AND AGITATE – 2 MINUTES

REMOVE AND DRAIN



IMMERSE – 1 MINUTE



REMOVE AND DRAIN

JMPTC 154 C

Figure 1-13. Fingerprint removal operations.

g. Installation of Vapor Degreasers. Vapor degreasers must be installed to keep solvent vapor loss to a minimum. The degreaser should, therefore, be located away from abnormal air currents such as heating and ventilating equipment, open windows and doors, and out of direct line of any air flow or down drafts. Air exhaust systems should be provided only when necessary, such as required for a pit-installed vapor degreaser. A degreaser should not be located near open flames, any high temperature surfaces (above 750°F), or where direct sunlight will reach the vapor zone. Flames, sunlight, high temperature, and water will cause decomposition of the degreasing solvent. Decomposition products are toxic and corrosive gases. They are extremely dangerous to personnel and cause rapid rusting of equipment within a considerable area of the degreaser.

h. Miscellaneous Equipment. Other equipment that is necessary for efficient degreasing operations include storage tanks for retention of contaminated solvent, metal safety containers for the storage of cleaning rags, mops or absorbent materials, a solvent recovery still, and where required, an air exhaust system.

i. Safety Precautions of Vapor Degreasing.

(1) *Solvent hazards.* Degreasing solvents are narcotic and produce a feeling of exhilaration and intoxication similar to the more pleasant phases of alcoholic intoxication. Do not overexpose anyone to the vapor. Some workers deliberately expose themselves to trichloroethylene vapor and develop into "sniffers." Overexposure to the vapor may produce nausea, dizziness, headaches, and general ill feeling. Skin contact with the solvent removes natural skin oils resulting in excessive dryness and subsequent cracking and chapping of the skin. Solvent absorption through the pores may produce effects similar to breathing the vapor. These solvents decompose at high temperatures, producing gases that are very dangerous and corrosive. Attempts to neutralize an acid condition by using alkalies is also particularly dangerous. This will result in an explosive mixture.

(2) *Handling solvents.* Keep all solvent containers, drums, and storage tanks closed to avoid evaporation and vapor contamination of the area, except when using. Provide a pump for solvent transfer from storage containers to the degreaser. Never use buckets or pails for the transfer. This invariably leads to splashing and spillage. Clean up any spilled solvent immediately after adequately protecting yourself with safety equipment (*j* below). Do not use forced air to dry up spills as this increases air contamination. Use mops, rags, or other absorbing materials to soak up the solvent, place them immediately in closed metal containers and remove for drying. Transport and store sludges and used solvent in closed drums.

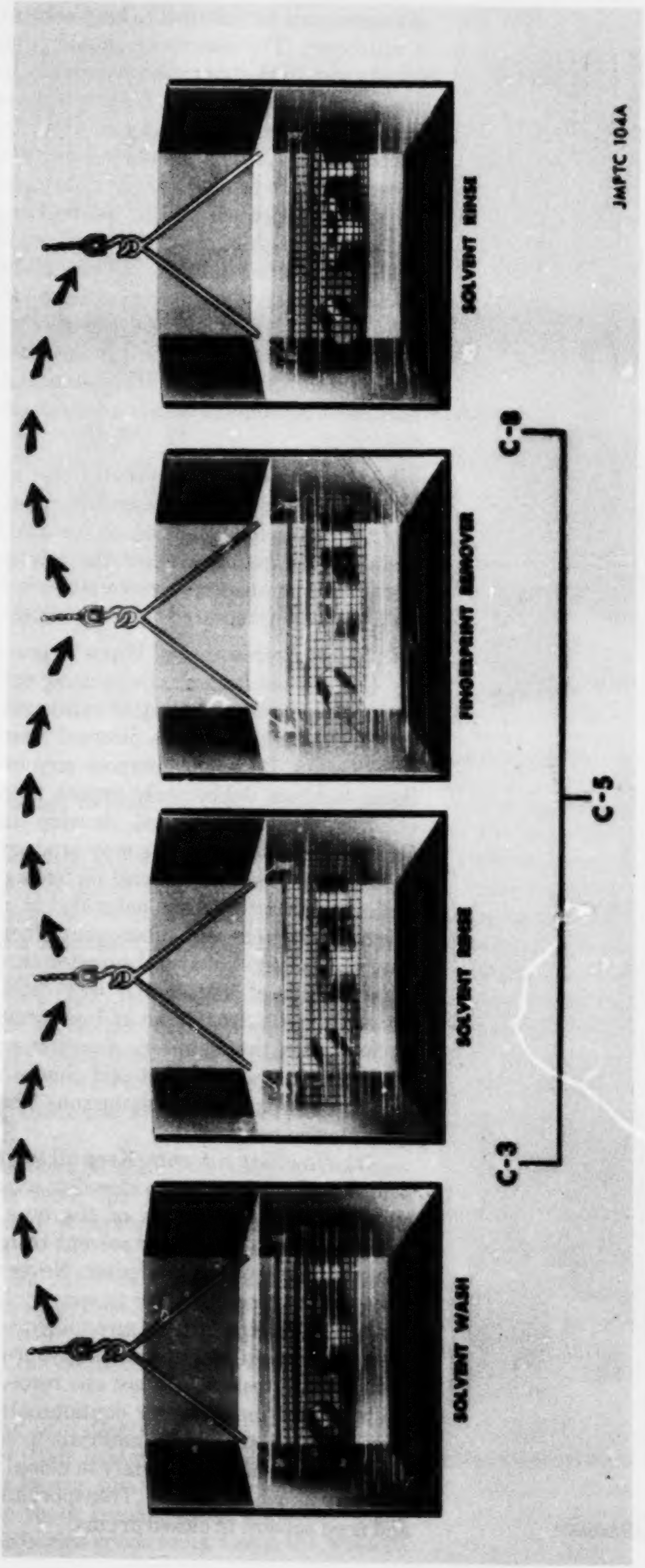
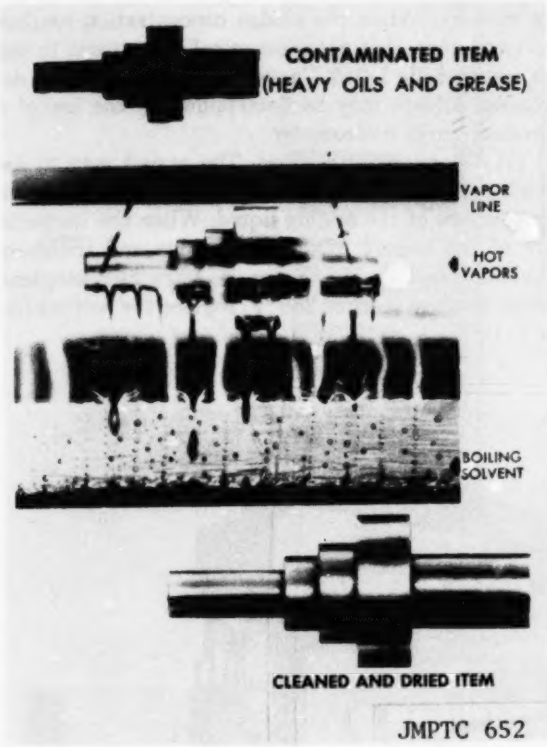

SOLVENT WASH
SOLVENT RINSE
FINGERPRINT REMOVER
SOLVENT RINSE
C-3
C-5
C-8
JMPTC 104A

Figure 1-14. Process C-5, solvent cleaning followed by fingerprint remover.


CONTAMINATED ITEM
(HEAVY OILS AND GREASE)
VAPOR LINE
HOT VAPORS
BOILING SOLVENT
CLEANED AND DRIED ITEM

JMPTC 652

Figure 1-15. Vapor degreasing principle.

j. Protective Equipment. Personnel who use the degreaser should obtain protective equipment, maintain it in good condition, and replace it as soon as it becomes worn or unsafe. The following items of personal protective equipment should be furnished, consistent with the hazards involved:

(1) Solvent-resistant gloves and aprons (fabricated from, or impregnated with polyvinyl chloride or neoprene plastics).

(2) Chemical safety goggles, and acid-type goggles, where there is any possibility of splashing.

(3) Hose masks, with hose inlet in a vapor free atmosphere; or air line masks with proper reducing valve and filter for use where conditions will permit safe escape if the compressed air supply should fail.

(4) Self-contained breathing equipment with stored oxygen or air.

(5) Rescue harness and lifelines.

k. Safety Rules. If solvent is properly handled, and equipment well designed, maintained, and operated, health hazards will be at a minimum. The following rules must be posted and observed by all operators:

(1) Know your equipment and its operation.

(2) Do not smoke near a degreaser. Inhaled vapor breaks down into acidic components by the heat of cigarettes.

(3) Handle all solvents in closed containers. Use pumps and pipelines to make transfers of liquid.

(4) Maintain the vapor within the degreaser by careful operation.

(5) Avoid inhaling vapor unnecessarily. Do not become a "sniffer."

(6) Never spray solvent above the vapor level, thus driving vapor into surrounding area.

(7) Do not lower work too rapidly into the vapor area, thus driving out vapor.

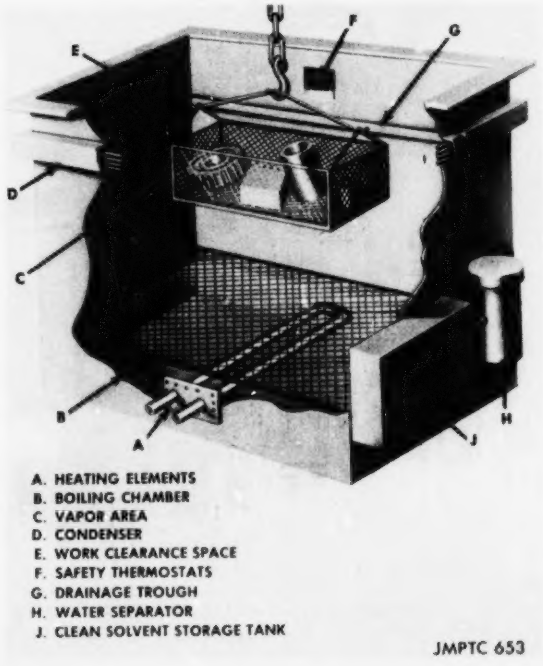
(8) Do not bring open flames, hot surfaces, or open electric heaters near the vapor.

(9) Do not permit the cleaning of clothing in the vapor degreaser. The vapor remains entrapped in the fabric and may result in serious blisters.

(10) If a unit must be entered for cleaning, do so only after all solvent liquid and vapors have been removed or dissipated, and then only if at least one other workman is in attendance on the outside. A workman entering a machine for any purpose should wear a mask which provides a source of outside air.

Table 1-1. Determining Solvent Contamination

Thermometer reading		*Specific gravity*		
O-T-634 Trichlor	*O-T-236 Tetrachlor*	*Trichlor*	*Tetrachlor*	*Sludge content*
188°F....	250°F.....	1.46	1.61	None
191°F....	252°F.....	1.36	1.47	10%
193°F....	255°F.....	1.25	1.33	20%
198°F....	260°F.....	1.17	1.22	30%


A
B
C
D
E
F
G
H
J
A. HEATING ELEMENTS
B. BOILING CHAMBER
C. VAPOR AREA
D. CONDENSER
E. WORK CLEARANCE SPACE
F. SAFETY THERMOSTATS
G. DRAINAGE TROUGH
H. WATER SEPARATOR
J. CLEAN SOLVENT STORAGE TANK

JMPTC 653

Figure 1-16. Basic vapor degreaser.

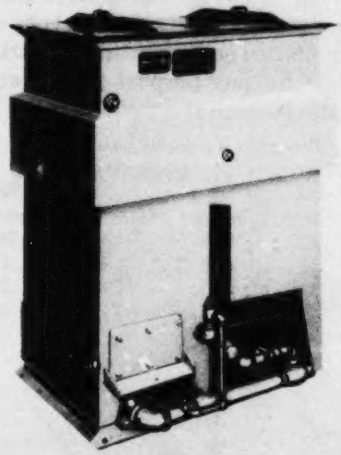
l. Selecting Items for Degreasing. Nonporous items of simple construction should be selected for vapor degreasing. Porous organic materials, such as leather, rubber, and fabrics may be damaged by the heat and the solvent action. Items joined with low-melting solders may be injured by tetrachloroethylene degreasing.

NOTE

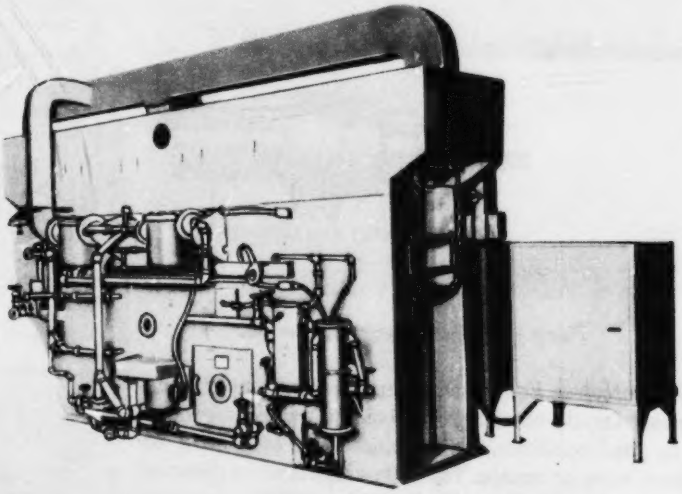
Sludge buildup will be reduced if items to be degreased are cleaned first by solvent spray to remove heavy greasy deposits.

m. Checking Solvent Conditions. As degreasing progresses, there is a gradual buildup of sludge with an increasing rise in the boiling temperature of the resulting mixture. When the sludge concentration reaches thirty percent, it is not economical to continue to use the material (fig 1-18). The percent of sludge in the degreasing solvent may be determined by the use of a thermometer or hydrometer.

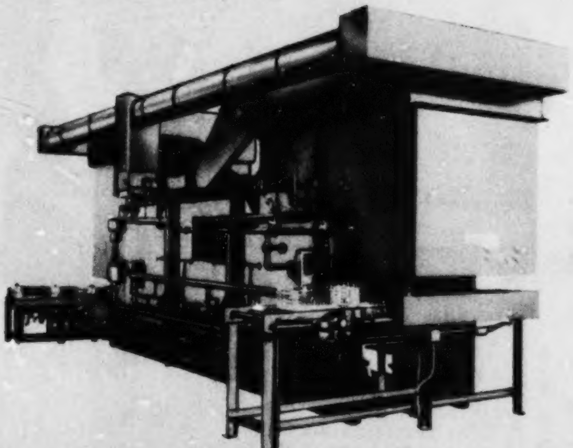
(1) *Temperature method.* The easiest way to determine the percent of sludge present is by taking the temperature of the boiling liquid. When the temperature of the boiling mixture of sludge and trichloroethylene reaches 198°F, or a tetrachloroethylene sludge mixture reaches 260°F, replace the solvent (table 1-1).



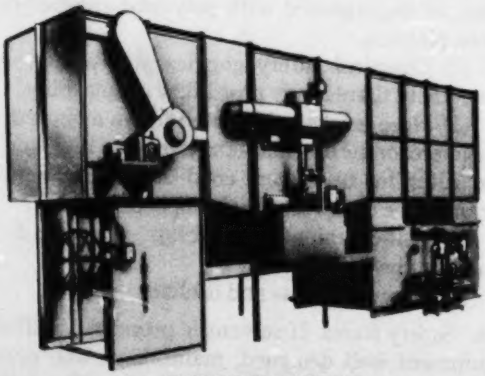
GAS OPERATED
VAPOR PHASE CLEANER



IMMERSION VAPOR PHASE CLEANER
WITH ULTRASONIC AGITATOR



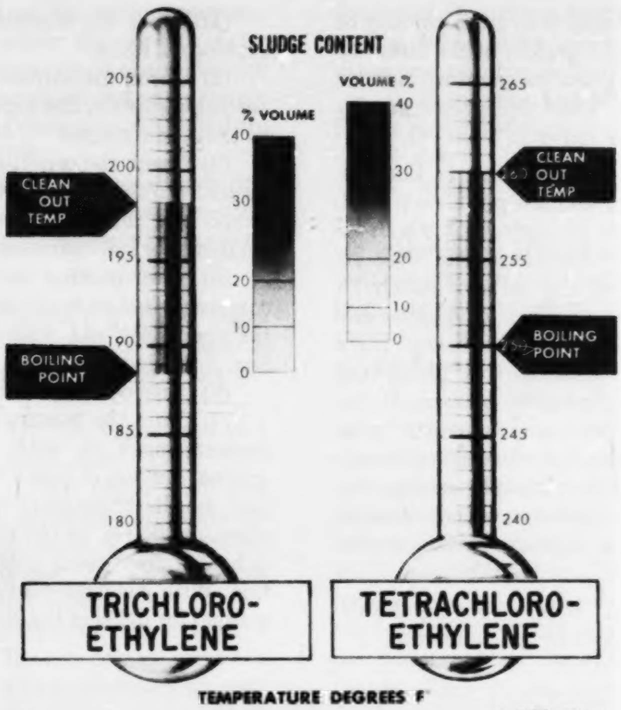
THREE STAGE CLEANER
(BOILING SOLVENT — WARM SOLVENT — VAPOR)



THREE STAGE CLEANER
(VAPOR — HOT SOLVENT — VAPOR)
WITH RUST PREVENTATIVE SPRAY SECTION

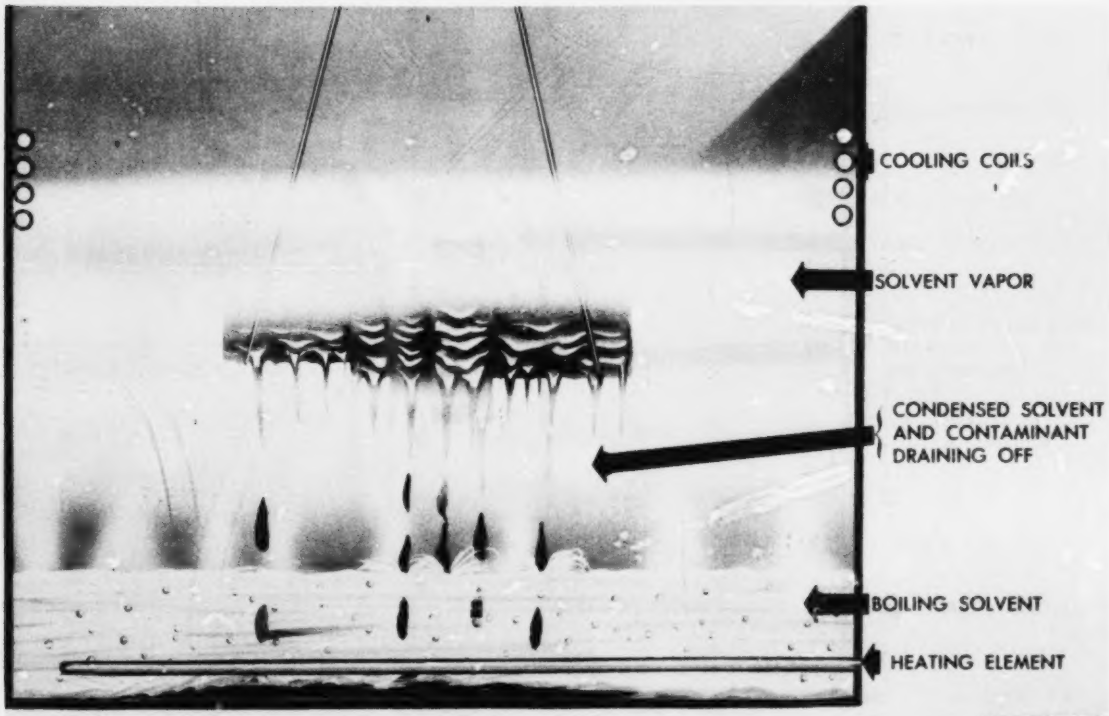
JMPTC 124

Figure 1-17. Types of vapor degreasers.


SLUDGE CONTENT
205
200
195
190
185
180
CLEAN OUT TEMP
BOILING POINT
% VOLUME
40
30
20
10
0
VOLUME %
40
30
20
10
0
265
255
245
240
CLEAN OUT TEMP
BOILING POINT
TRICHLORO-ETHYLENE
TETRACHLORO-ETHYLENE
TEMPERATURE DEGREES F

JMPTC 639 A

Figure 1-18. Boiling point of sludge mixtures.


COOLING COILS
SOLVENT VAPOR
CONDENSED SOLVENT AND CONTAMINANT DRAINING OFF
BOILING SOLVENT
HEATING ELEMENT

JMPC PG 107

Figure 1-19. Vapor degreasing with vapor alone.

(2) *Specific gravity method.* A hydrometer may be used to determine the specific gravity of the dirty solvent. A reading is made at room temperature, using a sample in a hydrometer jar. Read the specific gravity and compare with the values shown in table 1-1.

n. Acid Condition of Chlorinated Solvents. Continuous operation during humid weather produces a gradual breakdown of the vapor by hydrolysis which results in the formation of hydrochloric acid. This requires frequent checking of the solvent acidity. A rough test is made by lowering a clean, dry dipper into the vapor zone and collecting some condensate. Dip a strip of blue litmus paper moistened with distilled or deionized water into the condensed solvent. If the paper changes from blue to pink, acid is present in the vapor. This indicates that the solvent needs replacing. An accurate confirming check is made by sending solvent samples to a qualified laboratory where the acidity is determined by using a pH meter or a Universal pH indicator test paper.

o. Starting the Degreaser. Before starting the degreaser, the operator must perform the following:

(1) Check the degreaser and all pipelines for any evidence of leaks.

(2) Check the solvent level. It must be above the heating elements, the depth (2 to 4 inches) as specified by the manufacturer.

(3) Check the condition of the solvent. Determine its acid and sludge content.

(4) See that water, heat, and power sources are available for full operation.

(5) After making certain that the degreaser and equipment are in readiness, *open the shutoff valve* to the condenser and water separator precooler water line, if the degreaser is equipped with a precooler.

(6) Turn on the power for auxiliary equipment.

(7) *Start* the heating unit. For steam heated degreasers, *open the stem valve* slowly and permit a gradual buildup of steam. If a steam regulator is in the line, set the pressure at 15 to 20 psi for trichloroethylene and 60 psi for tetrachloroethylene. On electrically heated degreasers, turn the heat switch to ON position. With gas-fired degreasers follow manufacturer's manual for lighting the burners.

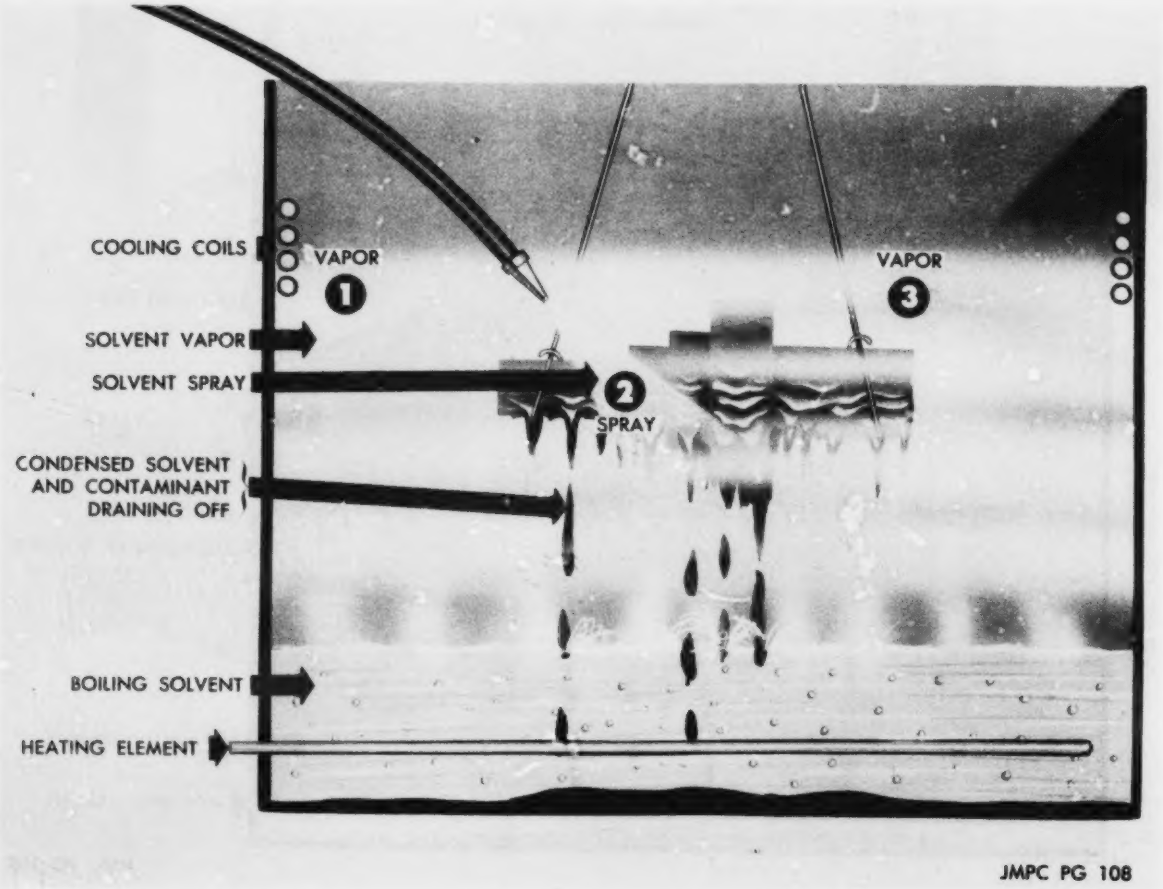


Figure 1-20. Vapor-spray-vapor cycle.

(8) After starting degreaser, but before commencing operations, check and adjust the cooling water temperature. Allow the vapor to reach the midcenter of the condenser coils and then adjust the water supply so that the temperature at the discharge end is slightly warm to the hand (90° to 120°F).

(9) Raise the cover slowly to minimize vapor disturbance. Check for vapor buildup by observing the presence of a wet line along the degreaser walls at the condenser level.

p. Degreasing With Vapor Alone (fig 1-19). Items to be cleaned by vapor alone should be of simple construction and lightly contaminated. Perform the following degreasing steps:

(1) Lower items slowly into the vapor area at a rate of not more than 12 feet per minute.

(2) Suspend items from hooks, racks, or in baskets, so that the liquid, as it condenses, can drain off without collecting in pockets or crevices. When the vapor stops condensing on items, the cleaning has stopped and items are ready for removal.

(3) Remove items slowly from the vapor area. If items are of small mass and heavily coated, some soil may still remain. This requires a second pass through the vapor. Hold items briefly above the vapor level for cooling. When items have cooled slightly, return to the vapor area to complete the cleaning.

(4) Keep items above the vapor line long enough for the liquid solvent to drain back into the degreaser.

(5) Remove from degreaser.

(6) Apply appropriate cleanliness tests (para 1-14).

q. Degreasing With Vapor and Spray Cycle. When contaminants on items include solid particles, such as chips, dust, or turnings, and equipment is available, the use of a spray nozzle is advisable. The steps for this cycle are shown in figure 1-20.

r. Degreasing With Warm Liquid-Vapor Cycle. Items which heat up too rapidly and slow down the rate of condensation are effectively cleaned using an extra warm or hot solvent tank. The warm tank is suitable for small items closely packed together. The liquid penetrates into blind holes and recesses dissolving and loosening the dirt. The method is suitable for the removal of flammable solvents and low boiling point oils from items, before subjecting them to the high vapor temperatures. The operations are as indicated in figure 1-21.

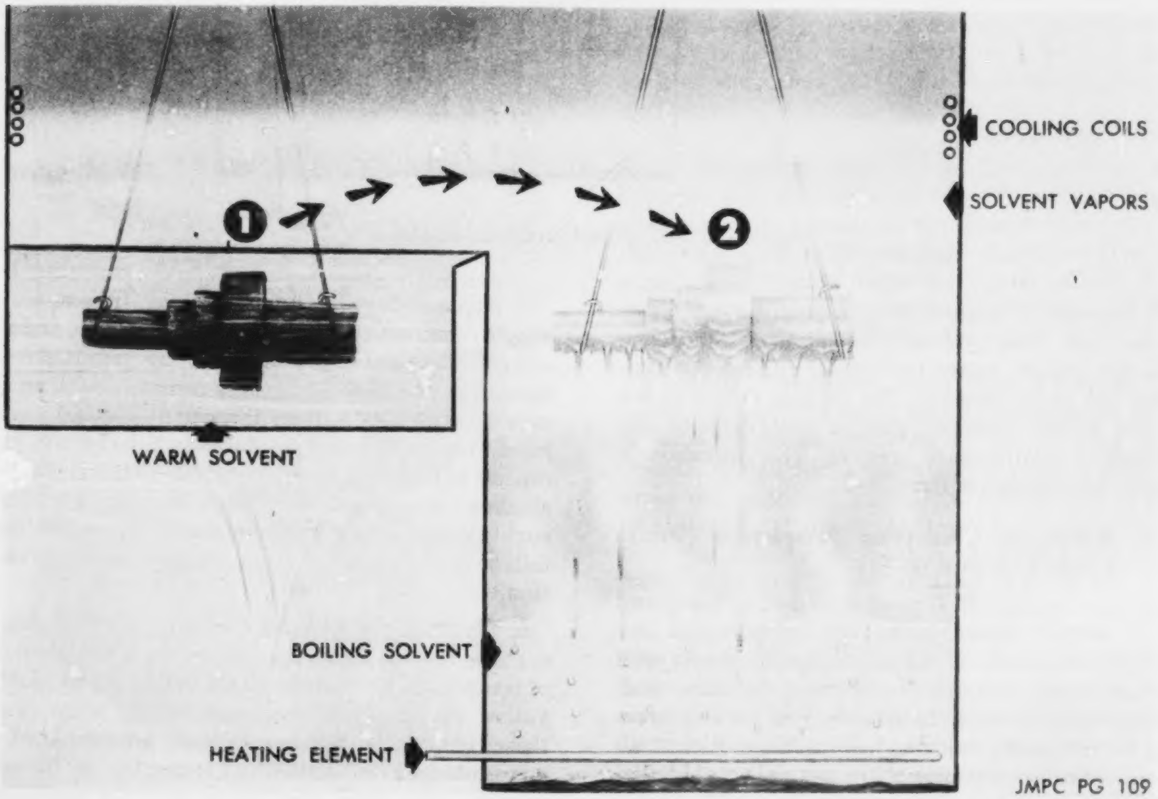


Figure 1-21. Warm liquid-vapor cycle.

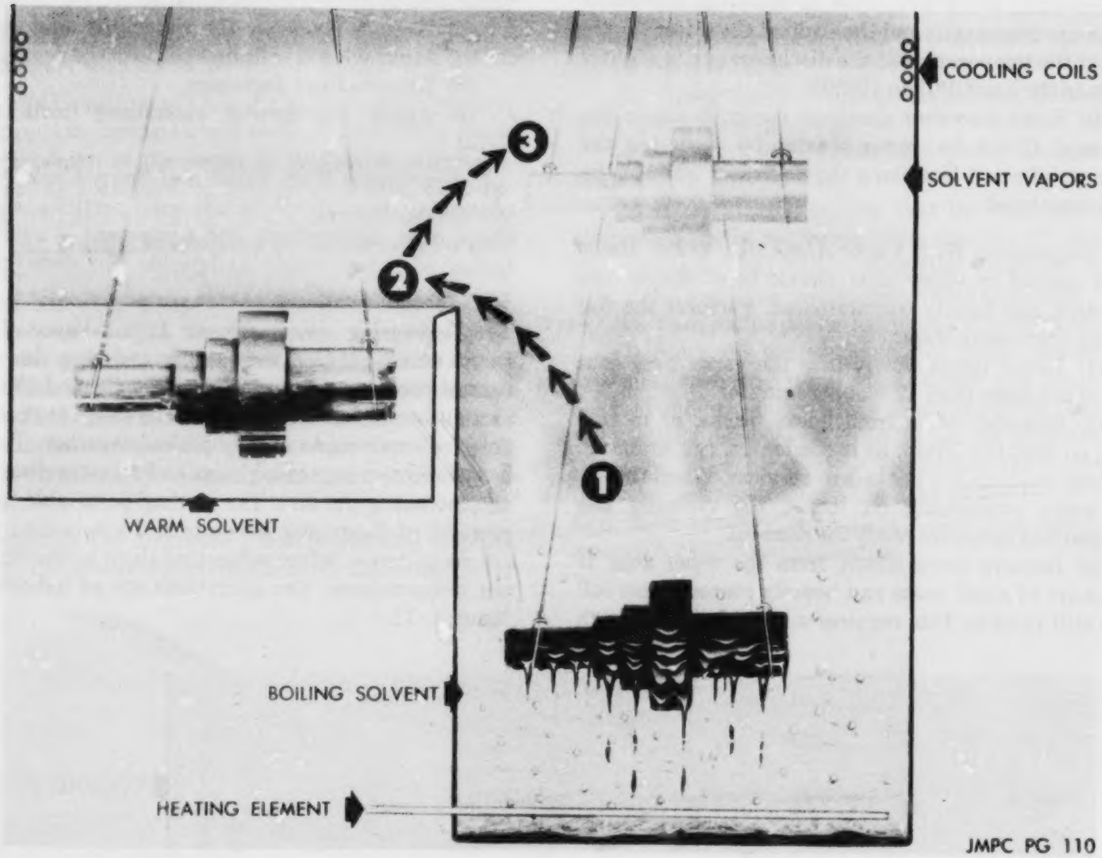


Figure 1-22. Boiling liquid-warm liquid-vapor cycle.

s. *Degreasing With Boiling Liquid-Warm Liquid-Vapor Cycle.* This cycle of cleaning is used where complex oils, greases, waxes, and similar difficult contaminants are to be removed. The surging action of the boiling solvent loosens caked-on contaminants and penetrates hard-to-reach crevices. This operation is conducted as shown in figure 1-22.

1-7. Alkaline Cleaning Processes (Processes C-9 and C-11)

Alkaline cleaning will remove shop dirt, soil, oily and water-soluble contaminants, and heavy waxes and buffing compounds. Highly alkaline solutions are used for heavy-duty cleaning of steel, and the more moderately buffered solutions are employed for aluminum and for aluminum and zinc base castings. Almost all manufacturing contaminants, except tightly adhering, insoluble compounds, such as chalk, etching inks, heavy rust, and mill scale, are removed. Some alkaline derusting processes will even remove light rust.

a. *Applicability of Alkaline Cleaning.* If items are of simple construction, have noncritical surfaces, and are composed of iron and steel, they can be effectively cleaned by the alkaline cleaning processes with an assurance that they will be thoroughly cleaned, uninjured, free from cleaner residues and fingerprints, and capable of passing the required tests. Metals cleaned in alkaline cleaning solutions must afterwards be thoroughly rinsed in hot water. A rinsing procedure that fails to remove residual alkali will give unsatisfactory results.

b. *Materials for Alkaline Cleaning.* Alkaline cleaners have become highly specialized and a great variety of compounds for specific cleaning jobs are available. Follow the supplier's recommendations when using these compounds. Alkaline cleaners are composed of mixtures of alkaline salts which loosen the soil for easy washing, plus small amounts of soap for increasing cleaner penetration, and buffering compounds for maintaining the alkalinity in the presence of acid-type contaminants that tend to neutralize the cleaner. The amount of soap present depends upon the type of equipment used and the hardness of the water. *For example*, alkaline cleaning by immersion requires more soap than pressure spray cleaning. This is because the pressure spray cleaning produces excessive foaming unless the soap concentration is reduced, so less soap is required.

(1) *Alkaline-type cleaning compound (P-C-436).* This is a powdered or granular compound especially suited for hot immersion cleaning of both ferrous and nonferrous metal items.

(2) *Alkaline electrocleaner (P-C-535).* This compound is used in preparing solutions which will conduct the low voltage current required to stimulate the bubbling action necessary for alkaline electrocleaning.

c. Equipment for Alkaline Cleaning. The equipment necessary for alkaline cleaning may vary with the process, but it must be capable of providing sufficient heat to maintain a boiling solution. There are several designs of cleaning machines, equipped to furnish heat by gas, steam, or electricity. Steam is usually considered the most efficient source of heat.

(1) *Immersion tanks (fig 1-23).* Hot alkaline cleaning tanks are commercially available in many sizes with capacities ranging from 10 gallons to several hundred gallons. They are furnished with standard equipment consisting of sludge drains, scum gutters, drain valves, hinged covers, dial thermometers, removable grilles, and automatic temperature controls. Tanks are furnished for use with natural, manufactured, and liquid petroleum gas, kerosene, electricity, and steam heat. Under field conditions, tanks may be devised from steel drums, or fabricated tanks which will meet the minimum needs of field operations may be used.

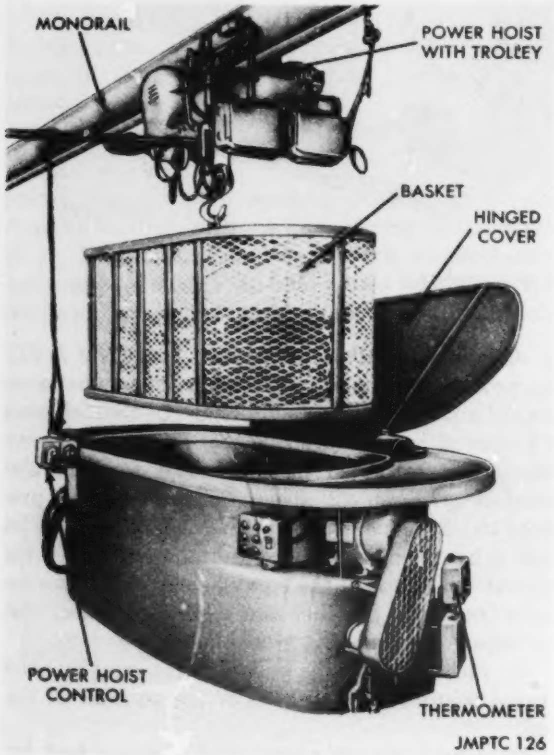


Figure 1-23. Alkaline immersion tank.

(2) *Alkaline spray washers (fig 1-24).* These machines are well adapted to large volume operations. The most widely used are the belt conveyor washers, built with cycles from single stage washing to multistage processing. These machines are adapted for cleaning many types of items of all sizes and shapes, placed singly or in baskets on a belt. Monorail spray washers carry items through washing, rinsing, and other stages. Some of these washers are arranged for straight line production. Others have a continuous return conveyor for loading and unloading at one station. Batch rotary-drum washers have a cylindrical drum with an interior spiral conveyor to carry work through the drum. The items are loaded in batches, cleaned while the drum rotates in one direction, and finally discharged by reversing the direction of the drum rotation. The rotation platform washers have a circular table that rotates slowly to carry work past washing and rinsing spray nozzles, and through a drying section.

(3) *Alkaline electrocleaning tanks (fig 1-25).* These tanks, designed similar to immersion tanks, are equipped with heating coils and overflow dams. Sheet steel electrodes hang from electrode rods in front of the coils and dams. The electrodes should have the top edges about 3 inches below the normal solution level and porcelain insulators at the bottom edges to prevent contact with the tank sides.

d. Safety Precautions for Alkaline Cleaning. The health hazards involved in alkaline cleaning are mainly skin irritations produced by the alkaline compounds. A high relative humidity in alkaline cleaning areas will aggravate irritations. Use protective goggles, gloves, and aprons to prevent eye or skin contact with the alkaline compounds. Avoid splashing hot solvents, which may result in burns and blisters.

e. Cleaning by Alkaline Immersion (Process C-9). This process consists of immersing and soaking items in an alkaline cleaner (P-C-436) and rinsing in clean water above 180°F. To accomplish alkaline immersion cleaning (fig 1-26) perform the following steps:

(1) Wear goggles, rubber gloves, and apron.

(2) Mix the alkaline cleaning powder in hot water. It does not readily dissolve in cold water and cakes on the bottom of the tank. Heating the solution may

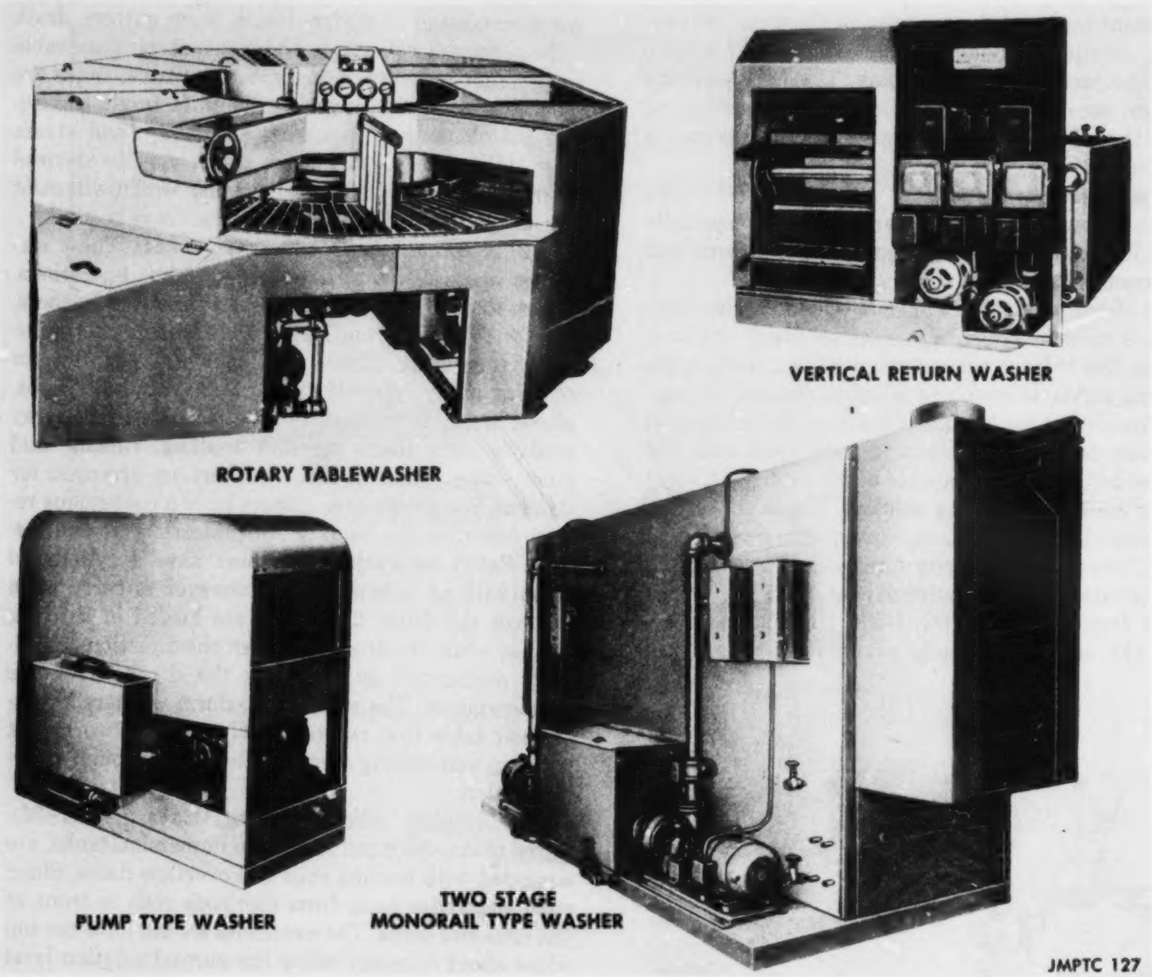


Figure 1-24. Types of alkaline spray washers.

cause a steam explosion of water trapped beneath the caked powder.

(3) Lower items to be cleaned into the hot (205° to 212°F) alkaline solution and allow to soak from 2 to 10 minutes, depending on degree of contamination.

(4) Agitate and brush items to speed up and improve cleaning.

(5) Transfer items to the rinse tank, allowing sufficient time for the solution to drain.

(6) Rinse items for 30 to 60 seconds in hot water (180°F or above). This high temperature is needed to dissolve the alkaline residues and speed up drying. Agitate in the rinse water to provide quicker and better rinsing.

(7) Drain and dry immediately.

(8) Apply appropriate cleanliness tests.

f. Cleaning by Alkaline Pressure Spray (fig 1-27). This process consists of subjecting items to a pressure spray of alkaline cleaning solution (P-C-436) followed by a rinse of hot water (above 180°F). Alkaline spray cleaning is performed in mechanical washing machines described in c(2) above. Spray cleaning is preferred to immersion cleaning when contamination on items is heavy enough to require the spray impact for removal. The force of the spray against the items removes both solid particles and soluble contaminants. The steps in alkaline spray cleaning are—

(1) Place items on the washer conveyor so that the sprayed solution can reach all of the surfaces of the item.

(2) Adjust sprayer nozzles and conveyor feed for effective cleaning.

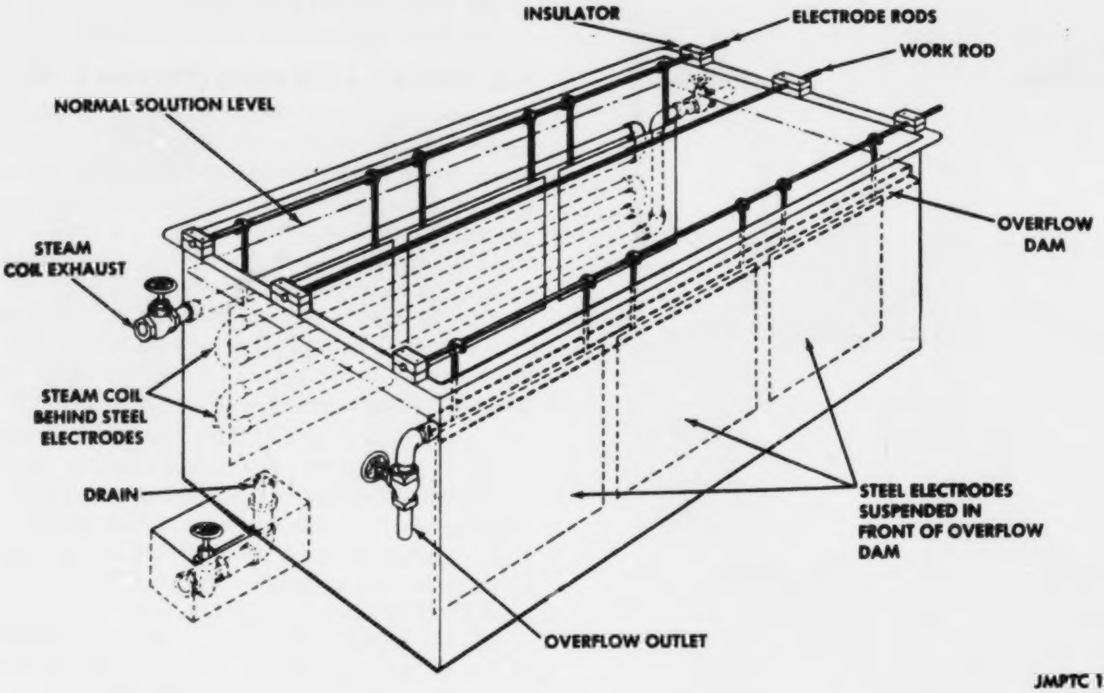

INSULATOR
ELECTRODE RODS
WORK ROD
NORMAL SOLUTION LEVEL
OVERFLOW DAM
STEAM COIL EXHAUST
STEAM COIL BEHIND STEEL ELECTRODES
DRAIN
STEEL ELECTRODES SUSPENDED IN FRONT OF OVERFLOW DAM
OVERFLOW OUTLET
JMPTC 128

Figure 1-25. Alkaline electrocleaning tank.

(3) Pass items through the cleaning, rinsing, and drying stages. If the machine has no separate drying stage, dry items immediately after rinsing by an approved procedure.

(4) Apply appropriate cleanliness tests.

g. Electrocleaning (Process C-11) (fig 1-28). This process consists of immersing items in an alkaline cleaning solution with the item serving as an element of an electrochemical cell. Plater's electrocleaning compound for steel (P-C-535) is used for alkaline electrocleaning. A hot water rinse (above 180°F) must follow the electrocleaning process. Decomposition of water with the evolution of the gases results when a low voltage current is passed through the electrocleaning solution to the item. Gas bubbles develop on the surface of the item and as they expand and escape to the surface, they exert both a "throwing off" and a "scrub-

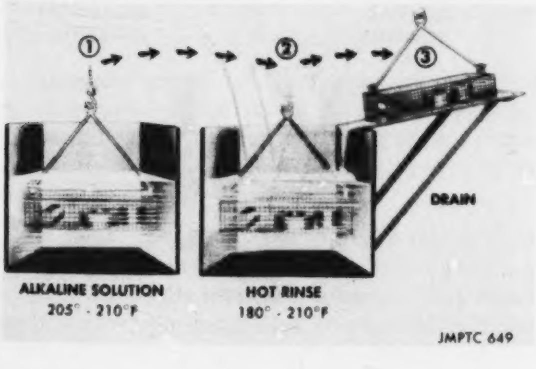

①
②
③
DRAIN
ALKALINE SOLUTION
205° - 210°F
HOT RINSE
180° - 210°F
JMPTC 649

Figure 1-26. Alkaline immersion cleaning.

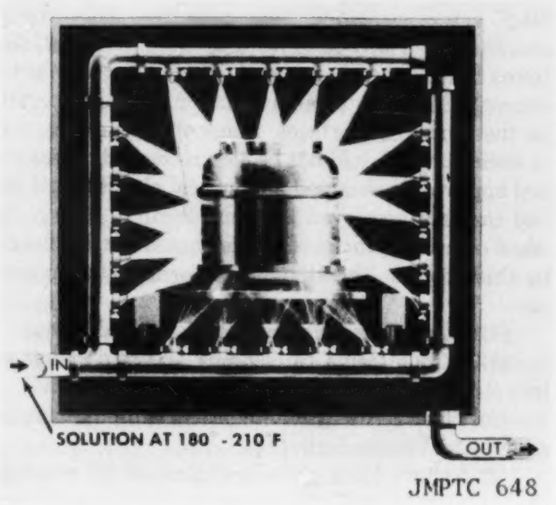
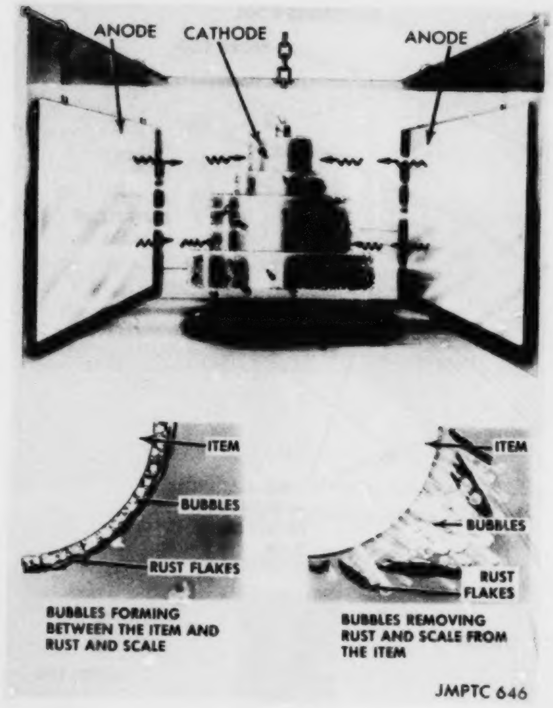

IN
SOLUTION AT 180 - 210 F
OUT
JMPTC 648

Figure 1-27. Alkaline cleaning by pressure spray.


ANODE
CATHODE
ANODE
ITEM
BUBBLES
RUST FLAKES
BUBBLES FORMING BETWEEN THE ITEM AND RUST AND SCALE
ITEM
BUBBLES
RUST FLAKES
BUBBLES REMOVING RUST AND SCALE FROM THE ITEM

JMPTC 646

Figure 1-28. Electrocleaning.

bing" action, which is very effective. This process should be used only on unit items or simple assemblies. Items having internal cavities should not be electrocleaned, since only small amounts of gas are liberated on these internal surfaces. Items of magnesium, zinc, or their alloys should not be electrocleaned unless special approval is obtained and special cleaners and special care are employed in their cleaning. Highly finished or critical surfaced items should not be cleaned by this process. The steps in performing this process are—

(1) Wear protective goggles; gloves and aprons.

(2) Attach items to cleaning fixtures and lower into cleaning tank with solution at 205° to 212°F.

(3) Clean items by making them cathodic (charged negatively) for 1 to 5 minutes.

(4) Relieve hydrogen embrittlement by reversing the current and making items anodic (charged positively) for 15 to 30 seconds. (If the tank does not have a reversing switch, two separate tanks are necessary.)

(5) Transfer items to the rinse tank. Allow time for excess cleaner to drain, without drying on the item.

(6) Rinse items for 30 to 60 seconds in overflowing hot rinse water (above 180°F).

(7) Inspect item for cleanliness by watching for an even flow of water from surfaces without any breaking of the water film.

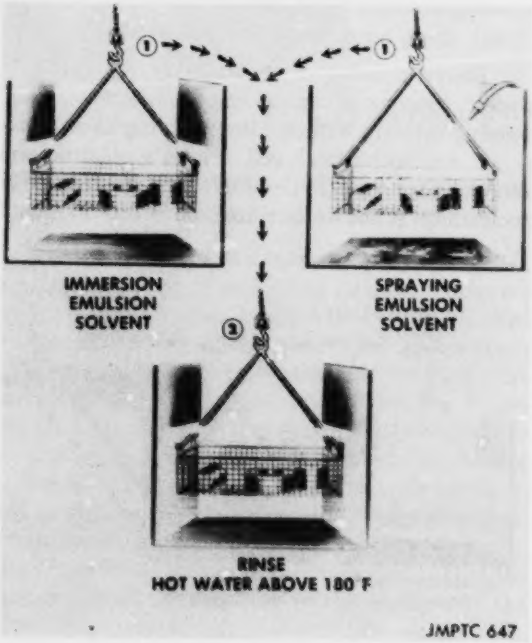
(8) Drain and dry immediately.

(9) Apply appropriate cleanliness tests.

1-8. Emulsion Cleaning (Process C-12)

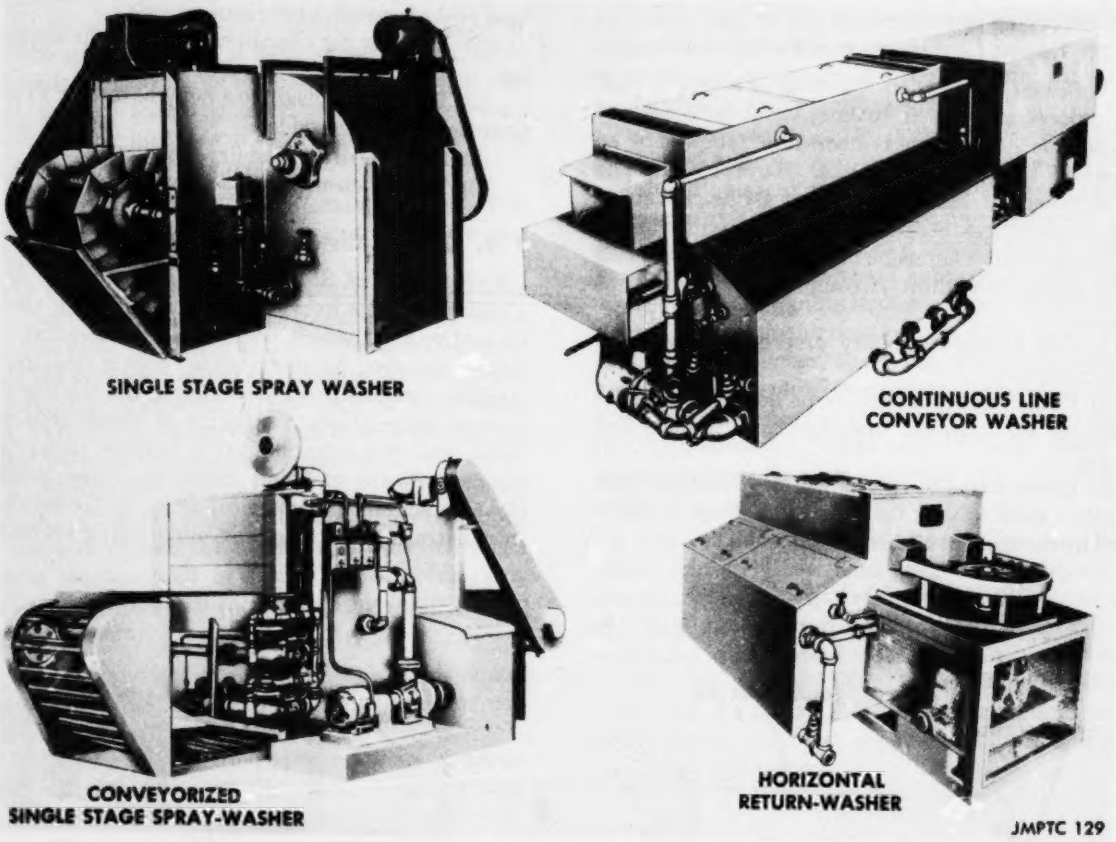
Emulsion cleaning is accomplished by blending an emulsifying concentrate with kerosene. The cleaning operation removes oil-soluble and water-soluble contaminants. Emulsion cleaning removes contaminants not readily removed by vapor degreasing alone or alkaline cleaning alone. It combines desirable features of both of these processes. Kerosene is mixed with the emulsifying agents and applied to items by immersion or spraying. Additions of small amounts of alkali to these emulsions are sometimes recommended where heavy oils and greases are to be removed (fig 1-29).

a. Applicability of Emulsion Cleaning. Emulsion cleaners are effective for removing stubborn pigmented, drawing, buffing, and polishing compounds and slushing oils. Since traces of a soapy film are left on an item's surface after emulsion cleaning, this type of cleaning is used only when the permitted degree of cleanliness is somewhat less than that obtained by the petroleum solvent or alkaline cleaning processes. Emulsion cleaning should not be used on any assemblies containing fabrics, rubber, and other organic materials, unless it has been reliably determined that no harmful effects will result. Also, it should not be used on any item or assembly which will tend to trap and hold rinse water that would eventually cause corrosion.



JMPTC 647

Figure 1-29. Emulsion cleaning.


SINGLE STAGE SPRAY WASHER

CONTINUOUS LINE CONVEYOR WASHER

CONVEYORIZED SINGLE STAGE SPRAY-WASHER

HORIZONTAL RETURN-WASHER

Figure 1-30. Emulsion spray washers.

b. Material Used for Emulsion Cleaning. The approved emulsion cleaning material for process C-12 is grease emulsifying solvent cleaning compound (P-C-444). It is a liquid concentrate capable of mixing readily with kerosene or other solvents.

c. Equipment Used in Emulsion Cleaning. The equipment required for emulsion cleaning is essentially the same as described for petroleum solvent cleaning in paragraph 1-5c. Representative types of spray equipment are shown in figure 1-30.

d. Emulsion Spray Cleaning (Process C-12). This process subjects items to a pressure spray of emulsion cleaner. It should be limited to cleaning unit metal items or very simple assemblies, on which all surfaces can be reached by the spray, and on which no surface will tend to trap the solution. The steps for this cleaning are—

(1) Wear protective goggles, rubber gloves, and apron.

(2) Adjust all spray nozzles for proper spraying.

(3) Check filter screens in the circulating system to permit a free flow of cleaner through the unit.

(4) Adjust temperature controls to keep heaters operating within the range recommended by the manufacturer of the equipment.

(5) Load items so that sprayed emulsion will reach all surfaces to be cleaned.

(6) Adjust nozzle spray pressure so all surfaces will be reached with enough impact to remove the soil.

(7) Pass items through or suspend them in the emulsion spray zone.

(8) Check results of cleaning and readjust spray nozzles as necessary to insure effective cleaning.

(9) Follow the pressure spraying by thorough immersion rinsing in clean hot water (180°F).

(10) If machine is equipped with a drier, allow items to remain in the drying zone until dry.

(11) If equipment does not have an automatic blowoff, dry items with clean compressed air or other approved drying procedure.

(12) Inspect for cleanliness and test as necessary.

e. Emulsion Immersion Cleaning (Process C-12). This process consists of soaking items in a tank of emulsion cleaner at room temperature, followed by an immersion rinse in clean water above 180°F. The emulsion solvent cleaner must not be heated above room temperatures, because of the fire hazard. The hot rinse helps remove emulsion cleaner residues, and aids in the drying procedure. Accomplish the cleaning as follows:

(1) Take necessary safety precautions and wear safety equipment.

(2) Place items into baskets, on hooks, or on racks to provide for complete drainage from pockets and crevices.

(3) Lower items to be cleaned into emulsion tank and allow them to soak for 1 to 10 minutes, as determined by the amount of dirt to be removd.

(4) If the tank is not equipped with agitation devices, agitate and scrub items to speed up the operation.

(5) Take items from the solvent tank after they have soaked enough to be clean.

(6) Examine for cleanliness while items are draining.

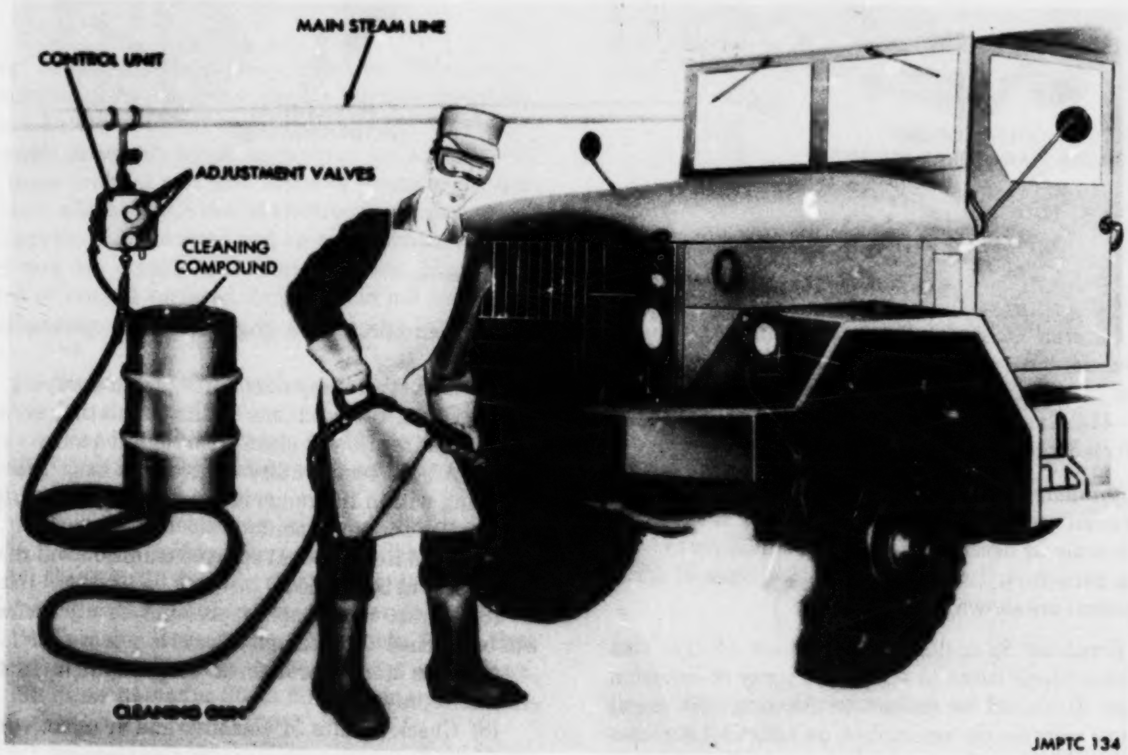
(7) Transfer, if clean, to a hot (above 180°F) water rinse for 30 to 60 seconds.

(8) Remove, drain, and dry.

(9) Test for cleanliness as appropriate.

1-9. Steam Cleaning (Process C-14)

a. Principle of Steam Cleaning (fig 1-31). Steam cleaning subjects items to a stream of steam alone or to a stream of steam with an added cleaning compound, followed by steam alone. Steam cleaning is a common cleaning process because of the relatively low cost of material, the simplicity of steam generating units, and the adaptability to various items to be cleaned. Steam cleaning combines three powerful cleaning actions: the chemical action of the detergent, in penetrating, wetting, and emulsifying surface de-



JMPTC 134

Figure 1-31. Steam cleaning.

posits; the physical action of the high pressure steam and solution working their way through successive layers of dirt and grease; and the dissolving action of the heat on oils, greases, and other deposits.

b. Applicability of Steam Cleaning. Steam cleaning has wide applications. It is used on vehicles and other field equipment too large to be soaked in tanks or conveyed through spraying machines. By using steam with detergent, all types of contaminants except solid rust and scale are readily removed.

c. Materials Used in Steam Cleaning. Materials required for steam cleaning are water for steam and steam cleaning compound.

(1) *Water for steam.* Water should be as free from scale forming contaminant as possible. Hard water will cause rapid formation of coil-clogging scale and increase the corrosion of the steam material. Use of water softening equipment is essential in hard water areas. Periodic descaling of steam coils is also an important preventive maintenance operation.

(2) *Steam cleaning compound (P-C-437).* This is a uniformly granular mixture of alkaline compounds and soaps developed for use in high pressure steam cleaning machines. It is a noncaking, nonclogging blend of powders which should not cause skin burn or sneezing to users.

d. Equipment Used in Steam Cleaning. The equipment required for steam cleaning may be either stationary or portable.

(1) *External source, pressure jet, steam cleaner (MIL-C-21074) (fig 1-32).* This steam cleaner is used with an outside steam source for the cleaning of vehicles and vehicle parts, aircraft engines, machinery, floors, and other equipment and surfaces. The steam cleaner consists of a mixing unit, intake and discharge hoses, and the cleaning gun. The mixing unit draws the prepared cleaning solution from a separate solution drum or container through the intake hose to the chamber where it is mixed with the live steam. This provides a wet stream of steam and cleaning compound through the cleaning gun. The end of the inlet hose is equipped with a strainer. This prevents the entry of solid particles which might clog the unit. The discharge hose is equipped with couplings for extending the length to reach all areas of the item. The cleaning gun consists of a swivel handle assembly, an insulated handle, tube fittings, and nozzles for round and flat jet spraying.

(2) *Electrically operated, wheel-mounted pressure jet steam cleaner (MIL-C-21074) (fig 1-33).* This steam cleaner is designed for portable operation for cleaning aircraft, vehicles, and miscellaneous ground equipment. It uses vaporized steam spray and hot water, with or without a steam cleaning compound, forced through a high pressure rinse system. A four-wheeled base permits maneuverability. A metal cabinet incloses the working components, except valve handles, relief valves, connections, and electrical outlets. A burner, which uses light diesel oil or kerosene, furnishes heat to the steam generator. Valves, pressure gauges and other controls are available for safe operation of the cleaner. A steam cleaning gun has interchangeable round and flat nozzles.

(3) *Spray-rinse vapor pressure cleaners (MIL-C-4036).* There are two styles of combination vapor and high pressure rinse, gasoline engine operated cleaners. Style 1 is mounted on four industrial type, pneumatic-tired wheels with a towing handle. Style 2 is mounted on a two-wheel automotive type trailer with towbar and folding leg for balance. Both styles of cleaners have as major components: a steam generator, heating coils, burner, fuel tank, pump, gasoline engine, motor generator, control panel, concentrate solution tank, compound metering device, pressure control switch, hour-meter, intake and discharge hoses, and vapor-and-rinse cleaning gun with swivel handle, air-cooled grips, and rinse and vapor nozzles.

e. Safety Precautions of Steam Cleaning. Boots, rubber aprons, gloves, and goggles must be worn to protect against the hot steam and avoid burns from handling the hose and nozzle. When steam cleaning compound is used, avoid excessive contact of the material with the eyes and skin. The closing off and shutting down of a portable steam cleaner requires careful safety procedures. The supplier's manual should be consulted at all times.

CAUTION

Steam cleaning may damage electrical wiring insulation, upholstery materials, antifriction bearings, etc.

WARNING

Remember that steam causes very serious burns! Be careful at all times!

f. Steam Cleaning Operations. The detailed operations of steam cleaning will vary with the type of equipment. It is advisable to follow the operator's manual that is provided for each type of unit. The steps for operating one type of portable, electrically driven steam cleaner are—

(1) Wear appropriate protective clothing.

(2) Prepare cleaner for operation by checking assembly, water supply, electrical source, fuel supply, proper lubrication, and position of all valves, open or closed, as required.

(3) Follow the instruction manual for starting the jet cleaner. When water is circulating through the system at the proper rate, start the burner.

(4) Prepare soap concentrate, following instructions on cleaner container.

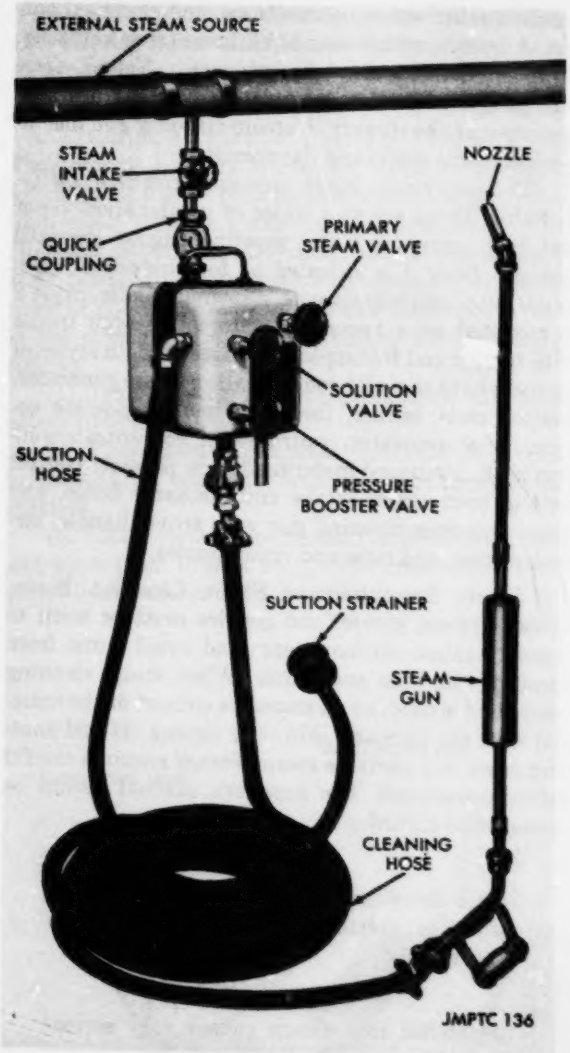


Figure 1-32. External source steam cleaning unit.

(5) Start soap pump assembly by turning on the soap control valve.

(6) Exhaust excess air from soap pump assembly. By loosening the tube coupling nut on top of the soap pump, check valve housing assembly. Observe the appearance of vapor emitting from the cleaning gun assembly. It will change appreciably when the soap concentrate is blending with the hot vapor.

(7) Direct discharge from cleaning gun assembly at the item requiring cleaning. Spray steam over the item allowing steam and compound to effectively carry out its cleansing action.

(8) Shut off the flow of soap concentrate and turn gun control handle from VAPOR to RINSE. Open soap control valve ⅛ turn from closed position to allow a small amount of soap solution to flow and thus prevent heating coil restriction.

(9) Rinse item with clean high pressure steam until all residues have been removed.

(10) Shut off steam unit, following instruction manual details with great care.

1-10. Abrasive Cleaning (Processes C-15, C-16, and C-17)

Abrasive cleaning comprises three processes and several materials. Abrasive cleaning breaks down solid, tightly adhering contaminants on item surfaces by blasting them at a high velocity and impact with hard or soft granulated particles. The effect of this abrasive action may be modified by controlling: hardness and type of grain; choice of particle size; velocity of abrasive steam projected on the item; and the method of application used in directing abrasive steam. The high velocity particles are directed against the item's surfaces with centrifugal wheels, high velocity air, or pressurized water.

a. *Applicability of Abrasive Cleaning.* With three processes of abrasive cleaning available, it is possible to clean a wide range of items contaminated with varying types and amounts of foreign materials. The processes can effectively produce a surface that is both chemically and mechanically clean. When surfaces are coated with heavy greases, this grease must be removed by a degreasing process before abrasive cleaning.

b. *Abrasive Blasting (Process C-15).* This process consists of directing a high velocity stream of abrasive against an item, driven by either compressed air or thrown mechanically from a centrifugal wheel. This process is best suited for cleaning rough castings or other surfaces where the removal of some base metal will not impair the item's function.

c. *Vapor Blasting (Process C-16).* This process subjects the item to a steam of atomized water containing a selected abrasive and suitable corrosion inhibitors. Vapor blasting is applicable for the removal of light coats of rust or scale from item surfaces where a slight amount of polishing will not hinder the function of the item.

d. *Soft Grit Blasting (Process C-17).* This process uses relatively soft abrasives with or without a corrosion inhibitor. The abrasive is carried by a high velocity stream of water directed at the contaminated surfaces of the item. This process is applicable to the removal of relatively soft contaminants and to cleaning items with surfaces that can tolerate only a minimum amount of metal removal during the cleaning process.

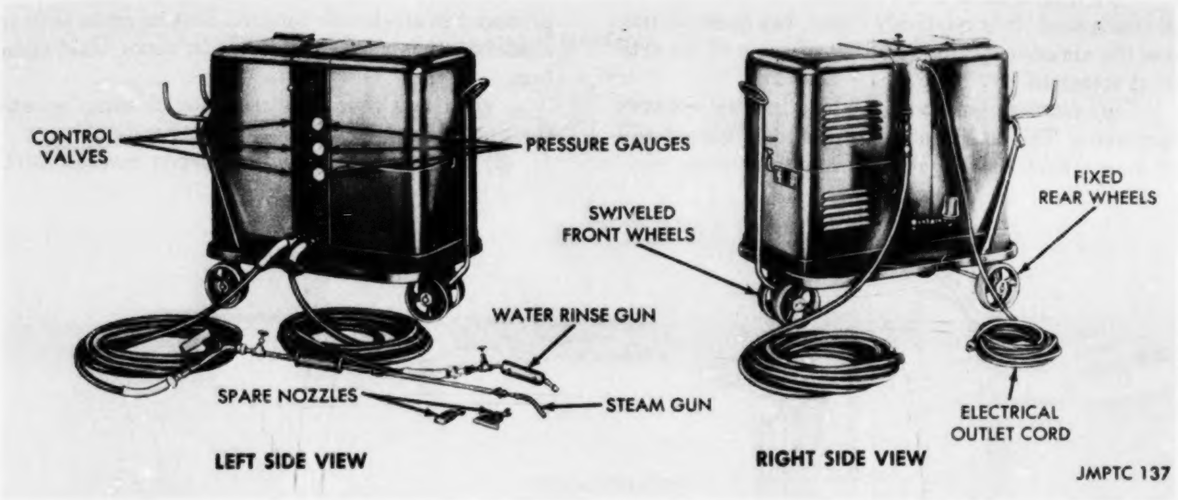

CONTROL VALVES
PRESSURE GAUGES
SWIVELED FRONT WHEELS
FIXED REAR WHEELS
WATER RINSE GUN
SPARE NOZZLES
STEAM GUN
ELECTRICAL OUTLET CORD
LEFT SIDE VIEW
RIGHT SIDE VIEW
JMPTC 137

Figure 1-33. Portable electric steam cleaner.

e. *Materials Used for Abrasive Cleaning.* The choice of abrasive materials is so wide and varied that almost any type of surface finish desired may be obtained by the proper selection of abrasive type, mixture, size, and stream velocity. The selection of the right abrasive will depend on the cleaning process, the desired finish on the item, the hardness of the item, and the type of scale or soil being removed.

(1) *Blast cleaning and peening grit and shot (MIL-S-851).* This material includes chilled cast iron or hardened cast steel grit and shot. The grit and shot is supplied in three types. Type IA is cast steel; Type IB is steel cut wire shot; and Type II is cast iron. The grit is available in two grades (grade A for special blast cleaning, and grade B for general blast cleaning). The shot is furnished in two classes. Class 1 is for peening, and class 2 is used in removing sand, scale, dirt, and rust from metal surfaces where grit cutting action is undesirable. This material is used primarily for process C-15, abrasive blast cleaning.

(2) *Inorganic abrasives.* There are several inorganic abrasives available in a wide range of grain sizes for use with vapor blasting, process C-16.

(*a*) *Novaculite* is a decomposed lava-type crushed rock that is available in mesh sizes from 100-mesh to 5000-mesh. The 5000-mesh material is about three times as fine as face powder. This material is used for close tolerance and precision work. When used with a corrosion inhibitor, it produces a finish that has extensive corrosion resistance.

(*b*) *Silica sand* is available in sizes from 50-mesh to 400-mesh. It is used for general cleaning, either wet or dry, and as a carrier medium for other selected abrasives.

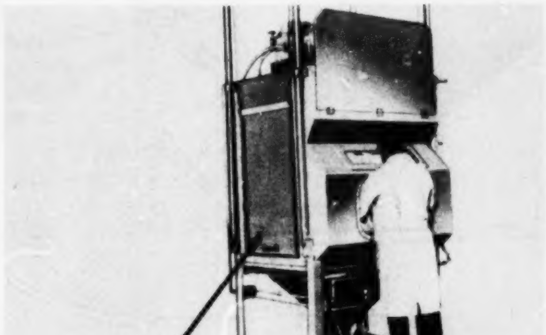

OBSERVATION WINDOW
RUBBER GLOVES
BLAST GUN
ITEM
WRIST SEAL
JMPTC 659

Figure 1-34. Liquid abrasive cabinet.

(c) *Quartz sand* is the familiar cleaned and sifted beach sand. It is relatively cheap, but does not possess the abrasive cutting qualities of some of the artificial abrasives.

(d) *Garnet abrasives* have long life and are very aggressive. The comparable mesh size of garnet will produce a much rougher surface than silica sand.

(e) *Aluminum oxide* is a hard synthetic abrasive produced in an electric furnace. Several grain sizes are available. It is used extensively in vapor blast operation.

(*f*) Glass beads are used for cleaning selected surfaces of steel, aluminum, and magnesium.

(3) *Soft abrasive grain for carbon removal (MIL-*

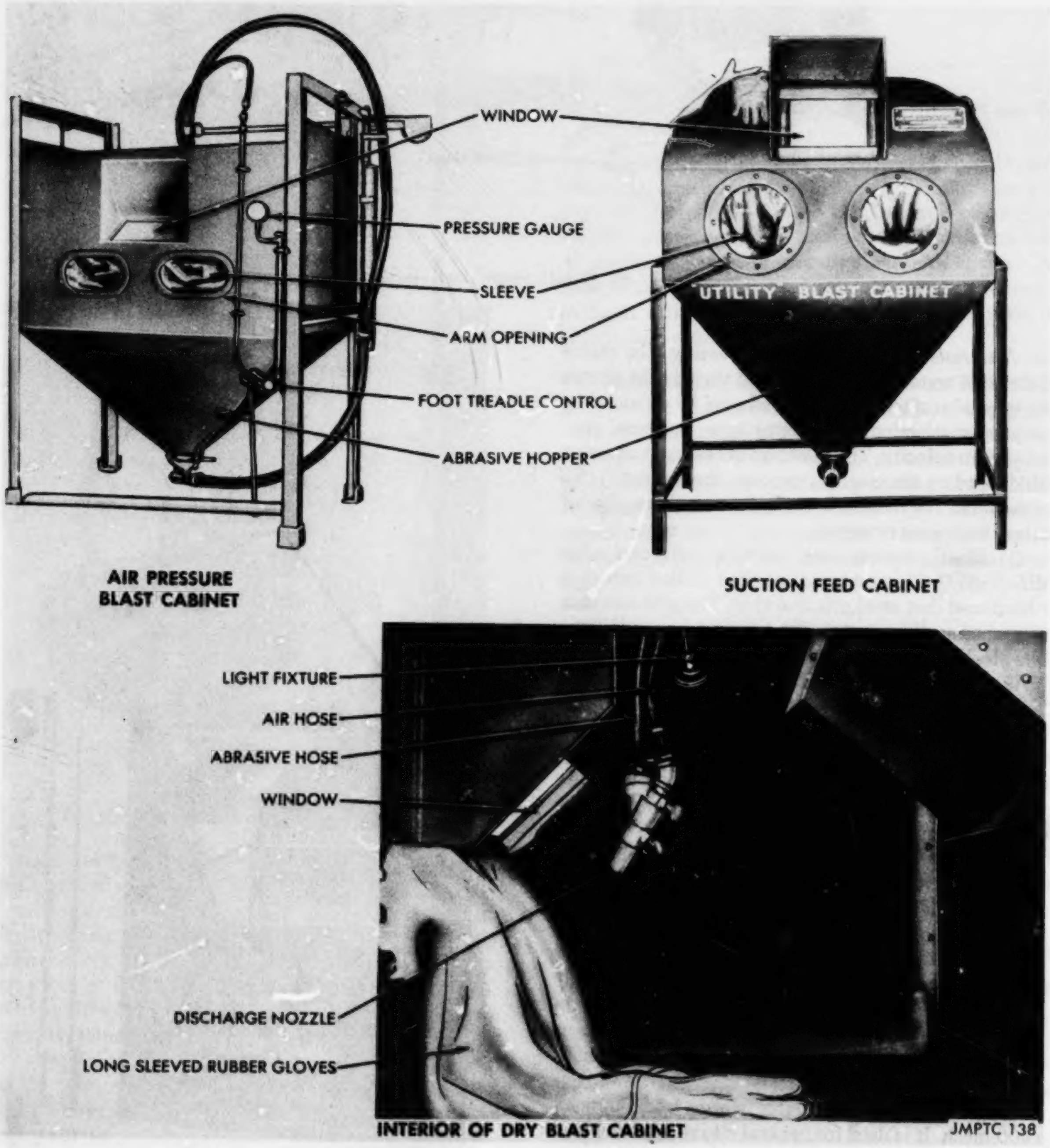
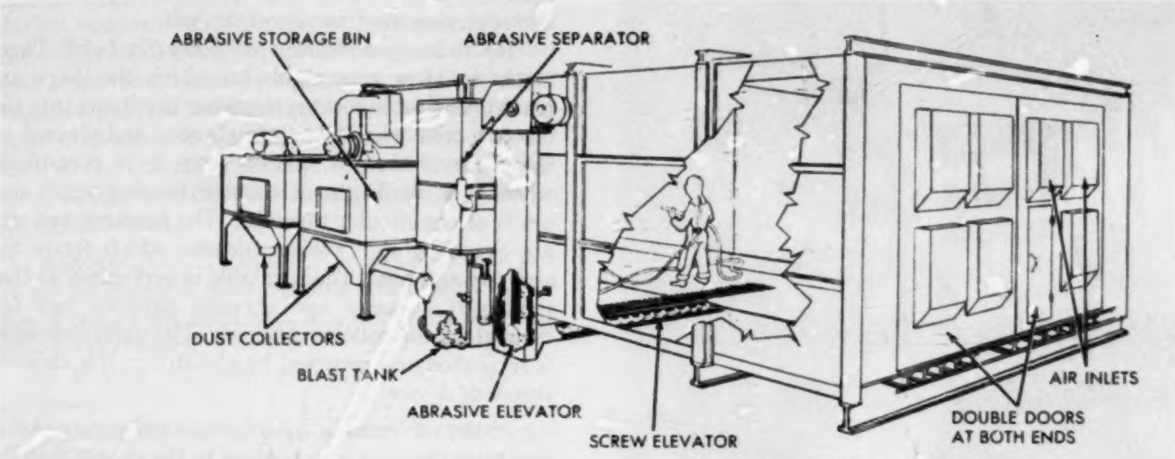
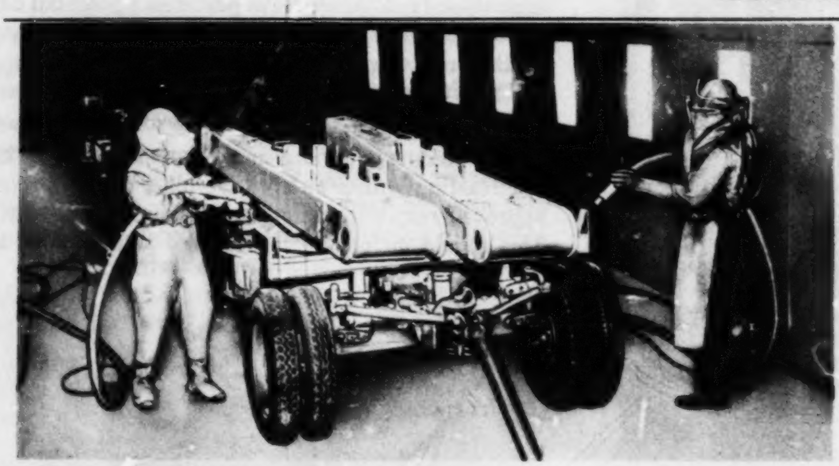

WINDOW
PRESSURE GAUGE
SLEEVE
ARM OPENING
FOOT TREADLE CONTROL
ABRASIVE HOPPER
UTILITY BLAST CABINET
AIR PRESSURE BLAST CABINET
SUCTION FEED CABINET
LIGHT FIXTURE
AIR HOSE
ABRASIVE HOSE
WINDOW
DISCHARGE NOZZLE
LONG SLEEVED RUBBER GLOVES
INTERIOR OF DRY BLAST CABINET
JMPTC 138

Figure 1-35. Dry abrasive cabinet.



BLASTING ROOM — EXTERIOR



INTERIOR OF ROOM DURING BLASTING OPERATION

JMPTC 139

Figure 1-36. Blasting room with operations.

G-5634). This abrasive material is manufactured from first quality apricot pit shell, pecan shell, black walnut shell. It is suitable for the removal of carbon from metal surfaces and cleaning of operating jet engines without deforming, marring, or scratching the surfaces. This material is specifically required for use with soft grit blasting, process C-17.

f. Equipment Used in Abrasive Cleaning. Abrasive cleaning equipment may consist of specially designed blast cleaning cabinets, blasting rooms, or blast cleaning machines.

(1) *Blast cleaning cabinets (MIL-B-45022).* These cabinets are inclosures equipped with necessary devices through which abrasive materials are ejected by air pressure against the surfaces to be cleaned. There are two types of cabinets described by this specification:

(*a*) Type I, liquid abrasive cabinets (fig 1-34), have a window in the front or top and two or more arm openings fitted with rubber sleeves. They are provided with a slurry hopper tank for mixing, storing, and recollecting the abrasive slurry. The slurry is delivered to the blasting gun by compressed air or circulating pumps.

(*b*) Type II, dry abrasive cabinets (fig 1-35), are similar in design to Type I except a dust collector is used to return the exhausted dust from the cabinet, and an abrasive reclaimer unit replaces the slurry hopper tank. The abrasive is delivered to the blasting gun either by direct pressure or by suction.

(2) *Dry, knockdown, blasting room (fig 1-36).* This is a sectional blasting room; large enough to accommodate the items, the sand blast hoses, nozzles, and the operators. The abrasives that are used are

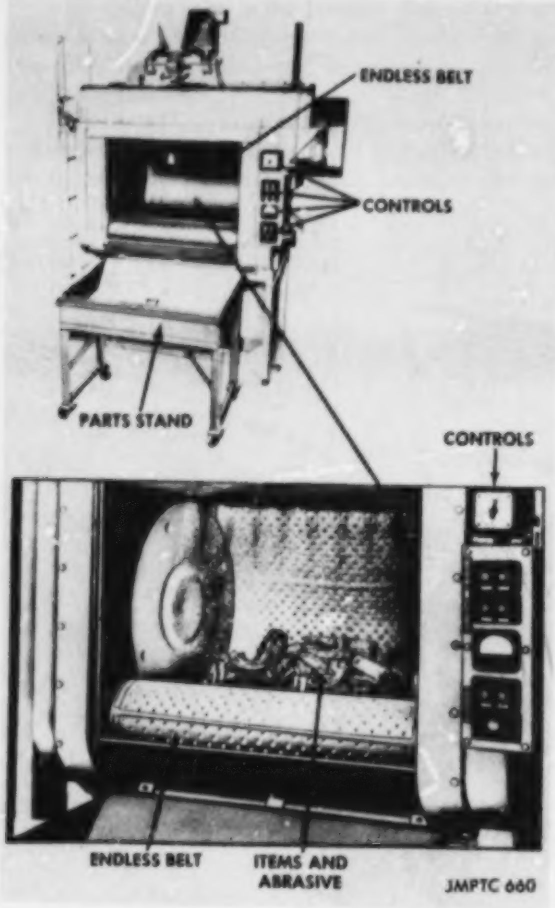


Figure 1-37. Tumbler-type abrasive blasting machine.

sandblast sand, refractory slag, metal cleaning abrasive grain, steel shot, and steel grit. The room consists of the sectional blasting room including floor-type screw conveyor, bucket elevator, abrasive separator, abrasive storage system, blast tank, dust collector, ventilating system, hoses, nozzles, and other equipment.

(3) *Tumbler-type abrasive blasting cleaning machine with dust collector (MIL-C-45081) (fig 1-37).* This is an airless, tumbler machine with a load capacity of not less than 5 cubic feet. The cabinet houses an endless belt conveyor upon which items are loaded, agitated, and unloaded. When the cabinet door is closed, the unit is dust and abrasive tight. The blast action is provided by controlled centrifugal force acting upon the abrasive. An abrasive recovery and handling system is an integral part of the unit. The dust collector is a separate cabinet equipped with its own motor. The items are tumbled on the endless belt which moves vertically so the items are tumbled against the vertical portion of the belt. The cleaned items are discharged from the blast chamber by opening the cabinet door and reversing the direction of the belt.

(4) *Table-type blasting machines (fig 1-38).* These machines have a turntable on which the items are placed. The table rotates, carrying the items into the blasting zone where they are abraded and cleaned by the abrasive thrown against them by a centrifugal wheel. The blasting zone is a steel housing which covers ¾ of the circular turntable. The entrance and exit are closed by split rubber curtains which retain the abrasive and dust. The turntable is perforated so that the spent abrasive and abraded particles can fall through to the collecting hopper. The usable abrasive is reclaimed and returned by elevator to the abrasive throwing device.

g. *Safety Precautions for Abrasive Cleaning.* Abrasive blast cleaning is hazardous to the extent that the high velocity of the abrasive particles a potential danger to the eyes and skin. Breathing of the dust created by the breakdown of the nonmetallic inorganic types of abrasives can lead to an occupational lung disease (silicosis). Proper protection is necessary.

h. *Protective Clothing and Equipment (fig 1-39).* For blasting within an abrasive blast cleaning room, approved respiratory equipment should be provided. This should include rubber covered helmets with air

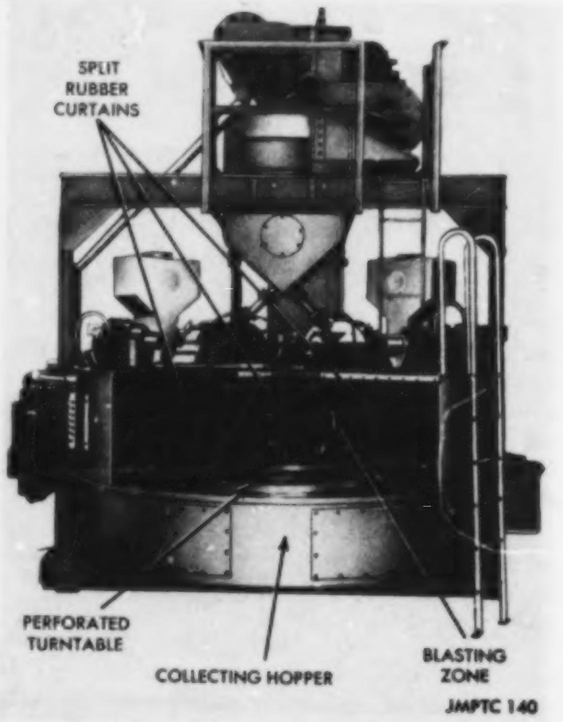


Figure 1-38. Table-type abrasive blasting cleaner.

fittings, hygienic helmet air supply units, replaceable plastic windows and protective screens. Armored leather gloves, leg and foot protectors, and protective aprons are also worn by operators within blasting rooms. Complete information concerning approved types of protective clothing and equipment for any types of blast cleaning may be obtained from the National Safety Council, 425 North Michigan Avenue, Chicago, Ill. 60611.

i. Abrasive Blast Cleaning (Process C-15). The procedure for abrasive blast cleaning will depend on the type of equipment employed. In general, the following steps are performed:

(1) Protect yourself with approved protective equipment.

(2) Mask off any portions of work that must not be blasted.

(3) Adjust pressures of compressed air to the type of surface being cleaned—60 to 100 psi for hard materials or 30 to 50 psi for the softer materials.

(4) Direct the stream of abrasive at a 90° angle to the work surface and move nozzle only as fast as the surface is cleaned.

(5) If surfaces are dusty and have metal chips clinging to them after blasting, blow off with compressed air or rinse in an inhibited cleaning solution.

(6) If iron dust and metallic particles continue to adhere to metal surfaces after rinsing, demagnetize items prior to blast cleaning.

j. Abrasive Blasting With Table-Type Equipment. When using table-type equipment, follow these procedures:

(1) Wear protective clothing.

(2) Place items to be cleaned on turntable. Items must be free of oil and grease. Do not overload the table. Place items so they do not shield each other from the blasting.

(3) Start the machine and as the table rotates, place additional items on the table. The rate of rotation of the turntable should be adjusted to the degree of contamination present.

(4) Examine items as they come through the exit curtains and reposition any poorly cleaned items and pass through the blasting zone again.

(5) Remove items from the turntable. Use gloves to prevent further contamination.

(6) Remove dust with compressed air or dip in an inhibited liquid rinse.

(7) Clean dust collector periodically.

k. Abrasive Blasting With Tumble-Type Equipment. When using the tumble-type equipment, follow these procedures:

(1) Place items in the cabinet on the rubber belt and close door.

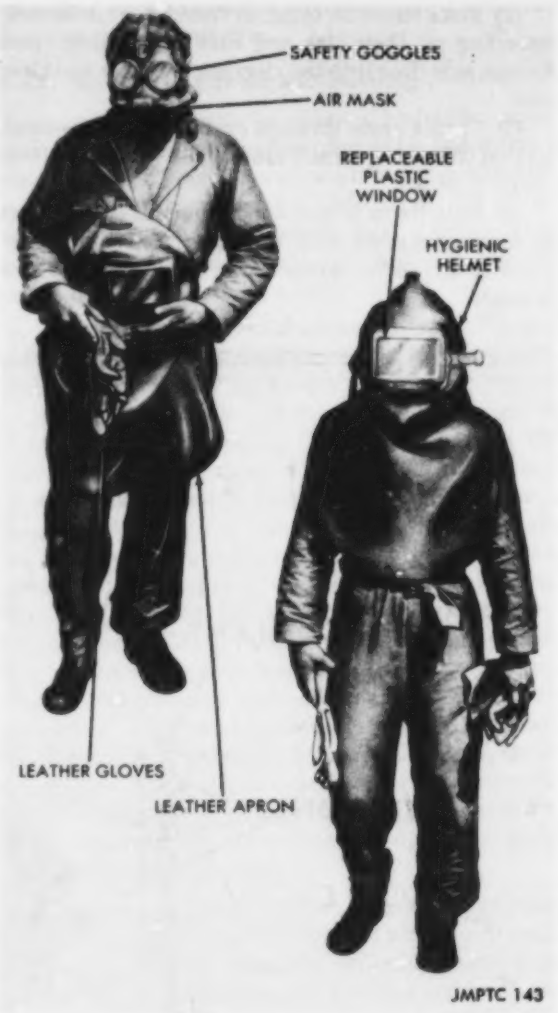


Figure 1-39. Protective clothing for abrasive blast cleaning.

(2) Start the machine and allow the abrasive to blast at the tumbling items.

(3) Stop the machine after about 5 minutes and inspect for cleanliness. If items are not clean, close door and run machine a few more minutes. Use rubber gloves when handling items for inspection.

(4) Reverse machine, open cabinet door and deposit cleaned items in a receiving basket or tray.

(5) Blow loose dust particles from items with compressed air or rinse in inhibited liquid rinse.

l. Vapor Blast Cleaning (Liquid Honing, Process C-16). In using a vapor blast cabinet, follow these steps:

(1) Wear rubber gloves while loading items into cabinet.

(2) Place items on table, in tumbler, or in baskets depending on their size and ease of handling, pass through side door into the cleaning chamber and close door.

(3) Thrust arms through rubber sleeve openings. See that sleeves fit tightly around the wrists and form a watertight seal.

(4) Hold items in one hand while blasting. Direct the blasting stream with the other. Leave items on turntable and rotate slowly if they are too large to handle easily.

(5) Adjust the pressure needed by moving the knee control lever.

(6) Continue the vapor blasting operation until all contamination is removed.

(7) Remove cleaned items from cabinet and dip them in a tank of corrosion inhibited rinse water.

(8) Keep this rinse tank heated above 140°F or more to speed up the drying.

(9) Dry the items as soon as possible after rinsing.

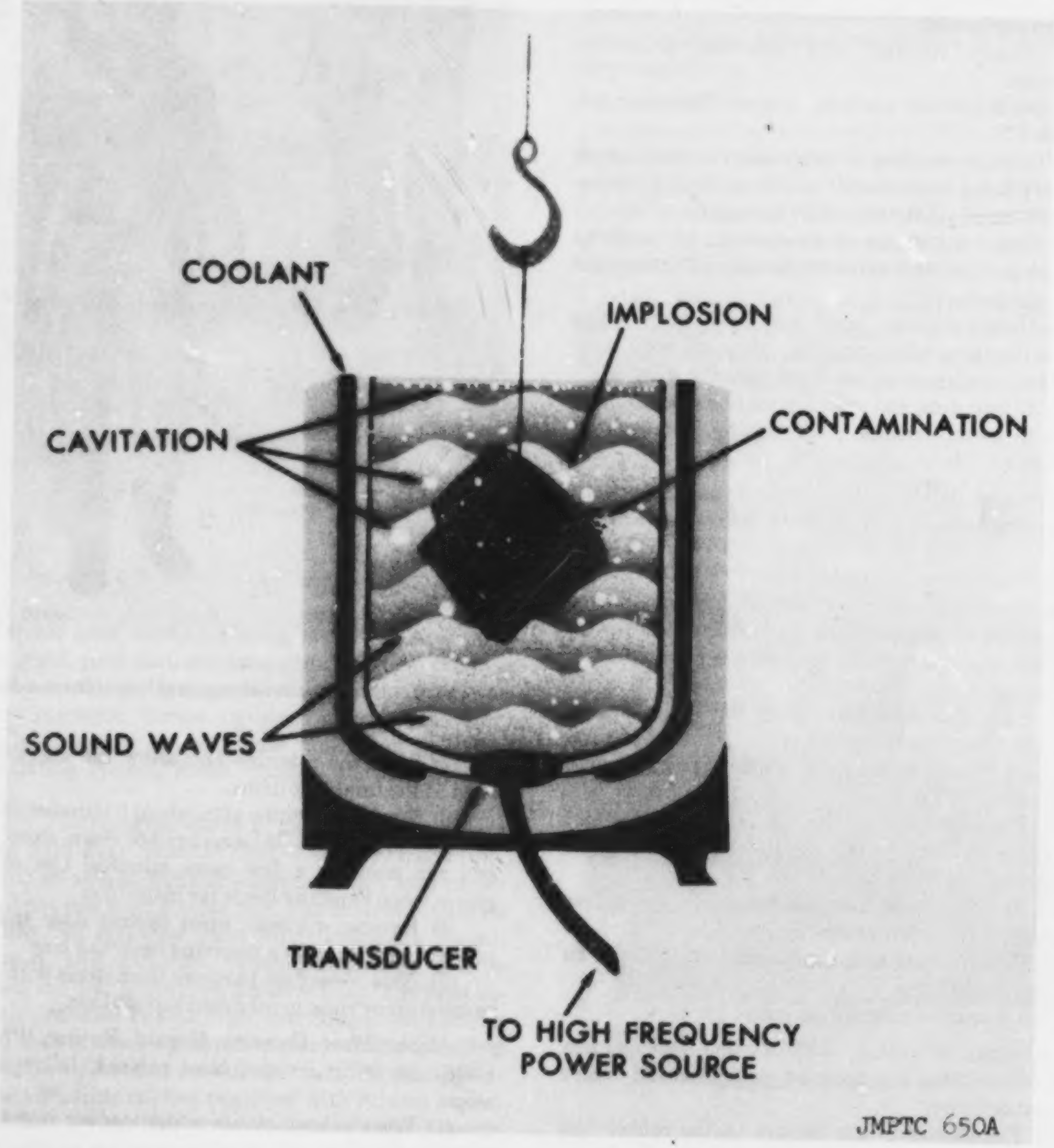

COOLANT
IMPLOSION
CAVITATION
CONTAMINATION
SOUND WAVES
TRANSDUCER
TO HIGH FREQUENCY POWER SOURCE
JMPTC 650A

Figure 1-40. Ultrasonic cleaning.

m. Soft Grit Blast Cleaning (Process C-171). This process is accomplished in the same cabinet as for vapor blast cleaning. The soft grits are used instead of the inorganic abrasives. These grits are used alone or with a suitable corrosion inhibitor. The steps to clean the items are essentially the same as outlined above.

1-11. Vapor Degreasing Followed by Fingerprint Removal (Process C-18)

When process C-18 is cited in a contract or specification, any one of the cycles described in paragraph 1-6 may be used, followed by the operations detailed in paragraph 1-5*h*.

1-12. Ultrasonic Cleaning (Process C-19)

This process converts electrical energy into high frequency sound waves. These sound waves help remove all foreign particles from the surface by focusing high frequency sound energy, above the human audible range of 20,000 cycles per second, upon the surfaces of the item while it is suspended in the bath. The ultrasonic waves do not replace the cleaning agent. They merely make the cleaning agent more effective by producing "cavitation" or "cold boiling" in the fluid. As a result, tiny bubbles form and collapse against the item being cleaned. This "bubble collapsing" provides the main suction or scrubbing action (fig 1-40). Ultrasonic cleaning is applied to non-absorbent materials such as glassware, metals, electronic equipment, and molded products. Hand wiping or brushing operations are eliminated by this process. Contamination in cavities, hollow indentations, small holes, and on precision finished surfaces is removed, thus giving a degree of cleanliness not achieved by any other process. The cleaning operations are carried out in a tank or chamber connected to an electronic generator, which supplies high frequency power. A transducer unit converts the electrical energy into ultrasonic waves in the stainless steel cleaning chamber. A recirculating filter reservoir removes the dirt from the cleaning solution and maintains the solution at a predetermined level and temperature. A rinsing area and a drier complete the equipment. Special water-detergent solutions are frequently employed but in some instances organic, chlorinated, or petroleum solvents may be used to advantage. Many cleaning agents commonly used for other cleaning processes are also excellent for use in ultrasonic cleaning. Some of these agents are water-emulsion cleaning compound (MIL-C-43616); cleaner—brightener (MIL-C-5410); and cold carbon remover (MIL-C-19853). Experience has shown that, when some special solvents are used, the sealing compound between the transducer disk and the solvent reservoir may be affected by the solvent. This is remedied by placing the special solvent in a pyrex beaker submerged in water in the solvent chamber and supported on rubber stoppers.

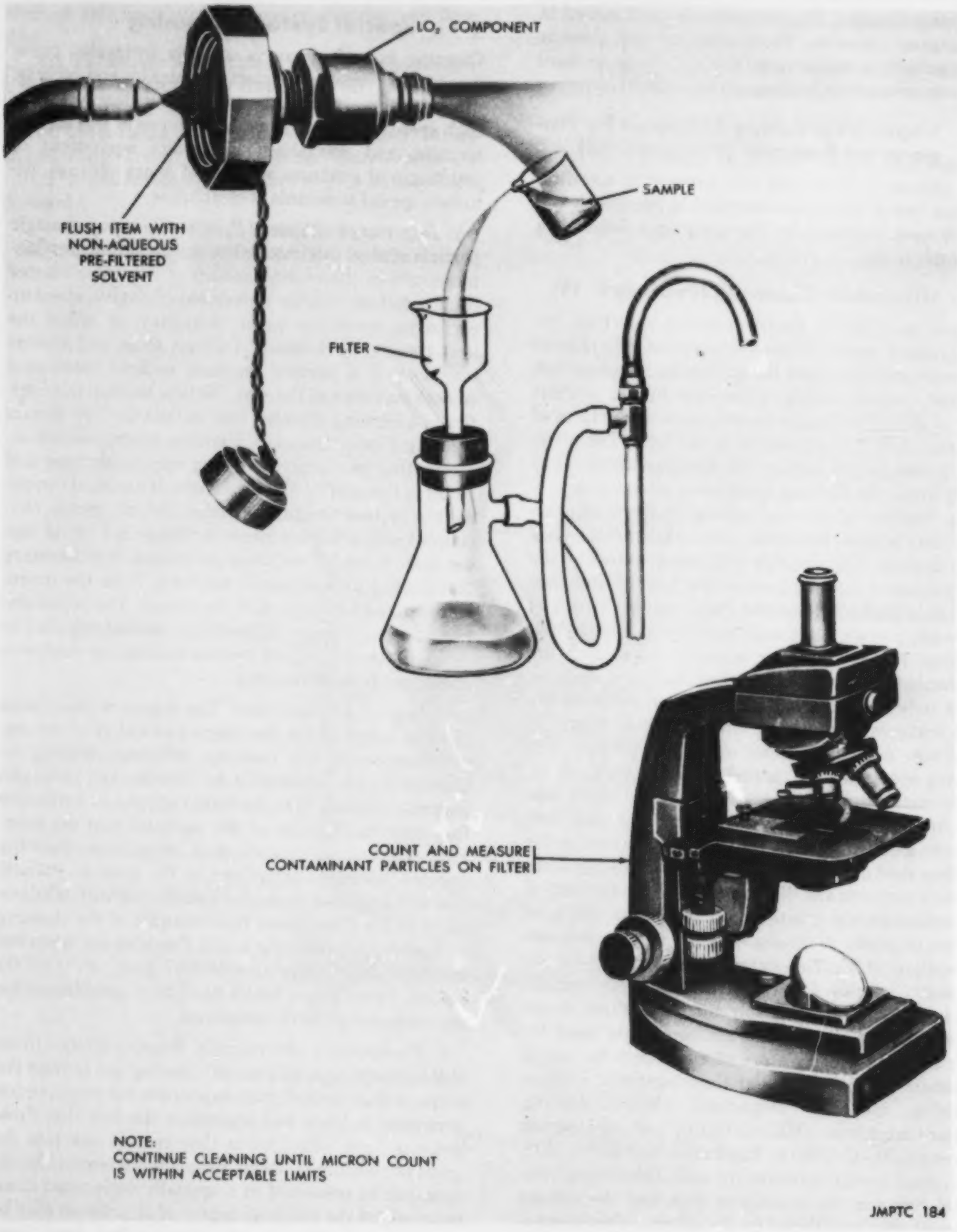
1-13. Special Systems Cleaning

Cleaning in such areas as complex hydraulic, pneumatic, and propellant systems of missiles and rockets; intricate primary coolant systems of nuclear weapons; high speed bearing systems of turbines in vessels and aircraft; and specialized electronics equipment of tracking and guidance systems of space vehicles, demands special standards of cleanliness.

a. Importance of Special Systems Cleaning. A single particle of steel can immobilize a critical bearing. Contaminants in the cooling system of a nuclear reactor could interfere with the movement of a valve, speed up corrosion, upset the water chemistry, or affect the heat transfer or radiation. O-rings, seals, and gaskets may leak if a particle becomes wedged between a smooth surface and the seal. Particle buildup in an orifice of a burning chamber may deflect the fuel stream creating a local "hot spot." Particles entrapped and accumulating in a noncritical area may break loose and result in the misfire or malfunction of a critical component or system. Organic particles, lint, oil, grease, etc., coupled with a sudden pressure change in a liquid oxygen system, could result in an explosion. It is necessary to obtain clean equipment delivered from the manufacturer and maintain this cleanliness. The accumulation of contaminants in a system must be controlled to avoid the possibility of system fouling, or explosive conditions from developing.

b. Degrees of Cleanliness. The degree of cleanliness must be adequate for the design and utility of the system component. *For example*, different cleaning requirements are established for fluorine and hydrogen peroxide systems than for liquid oxygen or hydrazine fuel systems. The size of the particles that are tolerated in a cleaning solution must be no larger than the smallest openings or orifices in the system. Particle size is determined through examination with a microscope of the filter taken from samples of the cleaning or flushing solutions (fig 1-41). Particles are measured in terms of microns (0.00003937 inch or 0.000001 meter). Particle size limits have been established for the various degrees of cleanliness.

c. Preservation Personnel's Responsibility. Since the details of special systems cleaning are beyond the scope of this manual, it is imperative for preservation personnel to know and appreciate the fact that these systems have components that require extreme degrees of cleanliness. Items requiring this extra cleanliness will be processed in a specially designated clean room where the required degree of cleanliness may be accomplished. When such cleaning has been com-


LO$_2$ COMPONENT
SAMPLE
FLUSH ITEM WITH NON-AQUEOUS PRE-FILTERED SOLVENT
FILTER
COUNT AND MEASURE CONTAMINANT PARTICLES ON FILTER
JMPTC 184

NOTE:
CONTINUE CLEANING UNTIL MICRON COUNT IS WITHIN ACCEPTABLE LIMITS

Figure 1-41. Determining particle size.

pleted, items are protected by a contamination barrier, such as a bag, wrap, plug, cap, blind flange or other device which will prevent contamination of the cleaned surfaces during all succeeding operations. The cleaned items in the contamination barriers should be marked with an appropriate color code to designate the system for which they have been cleaned. Preservation personnel, receiving items that have been processed in this fashion, must realize that the contamination barrier is considered a critical part of the item being packaged and any damage thereto, such as punctures, tears, abrasions, separation of seals, and leakage of flanges discovered upon inspection, necessitates a complete reprocessing through all previous steps. It is, therefore, incumbent upon all preservation personnel to recognize these processed items and handle them with the care their importance deserves.

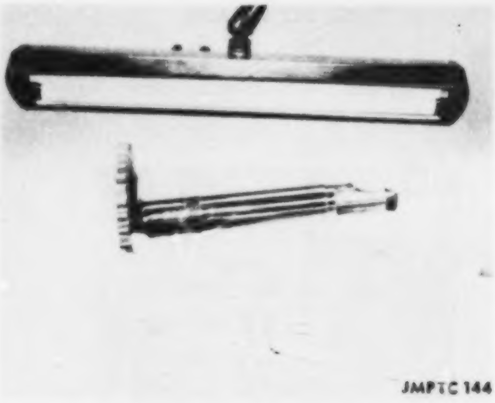


Figure 1-42. Visual test for cleanliness.

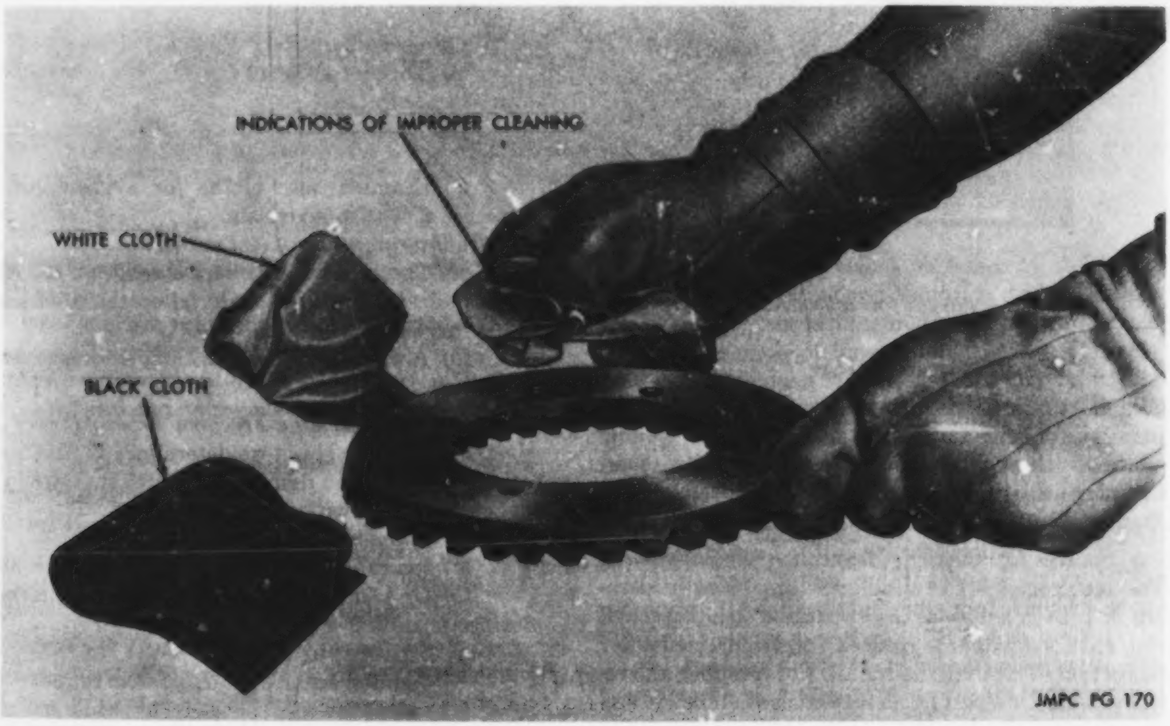


Figure 1-43. Wipe test for cleanliness.

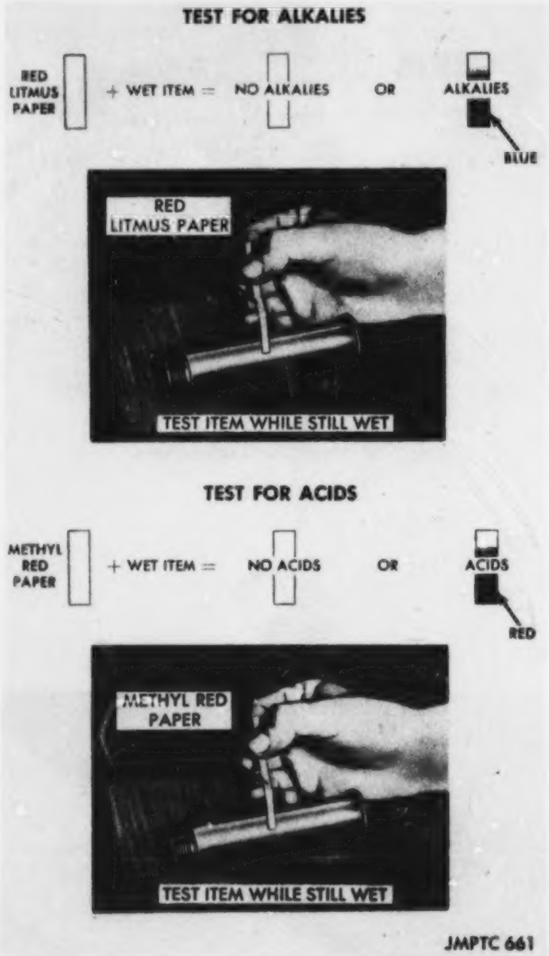


Figure 1-44. Freedom from acids and alkalies test.

1-14. Cleaning Inspection

Cleaning inspection insures proper cleaning before the item is processed further. It also conserves cleaning materials through their timely recovery for reuse. Cleaning inspection prevents inadequate cleaning with the attendant losses in time, labor, and materials.

a. *Sources of Cleaning Inspection Requirements.* The requirements for cleanliness are listed in paragraph 1-2. In addition, the applicable cleaning material specifications are sources for requirements for inspection of cleaning materials. For example, the requirements for a petroleum solvent are detailed in section 4 of Specification P-D-680.

b. *Visual Test for Cleanliness (fig 1-42).* This test visually determines freedom from or the presence of, foreign materials or corrosion.

(1) *Equipment required.*

(*a*) Lamp to insure adequate lighting.

(*b*) Gloves, barrier material, or other means of holding item to prevent contamination.

(2) *Procedure for test.*

(*a*) Hold item to strong light.

(*b*) Examine all surfaces for the presence of foreign materials and corrosion.

(3) *Interpretation of test results.*

(*a*) Presence of dirt, oil, grease, or other foreign materials on the item will be cause for rejection.

(*b*) Presence of corrosion on the item also will be cause for rejection.

c. *Wipe Test for Cleanliness (fig 1-43).* This test determines freedom from foreign material and corrosion that was not discovered in the visual test.

(1) *Equipment required.*

(*a*) Adequate light source.

(*b*) One piece each of clean, lint free, white and dark cloth.

NOTE

Linen, combed cotton, and lint free nonwoven fabric cleaning cloths (listed in the General Services Administration stores stock catalog) may be considered lint free for drying and inspection use.

(2) *Procedure for test.*

(*a*) Wipe a portion of the item being tested with the white cloth.

(*b*) Wipe another portion of the item with the dark cloth.

(*c*) Examine both cloths for evidence of the presence of foreign materials.

(3) *Interpretation of test results.*

(*a*) The presence of a dark smudge on the white cloth indicates a foreign material on the item and is cause for rejection.

(*b*) A white deposit on the dark cloth is cause for rejection.

d. *Test To Determine Freedom From Alkalies and Acids (fig 1-44).* This test determines if alkalies or acids remain on the item in quantities that would endanger the preservation of the item.

(1) *Equipment required.*

(*a*) Indicator papers-methyl red and red litmus.

(*b*) Or a universal indicating paper conforming to Specification O-P-94.

(*c*) Distilled or deionized water.
(*d*) Medicine dropper.
} Use if item cannot be tested while still wet from final rinse.

(2) *Procedure for test.*

(*a*) Wet a small area of item with distilled water, if not still wet from final rinse.

(*b*) Touch both the methyl red and the red litmus papers to the wet surface.

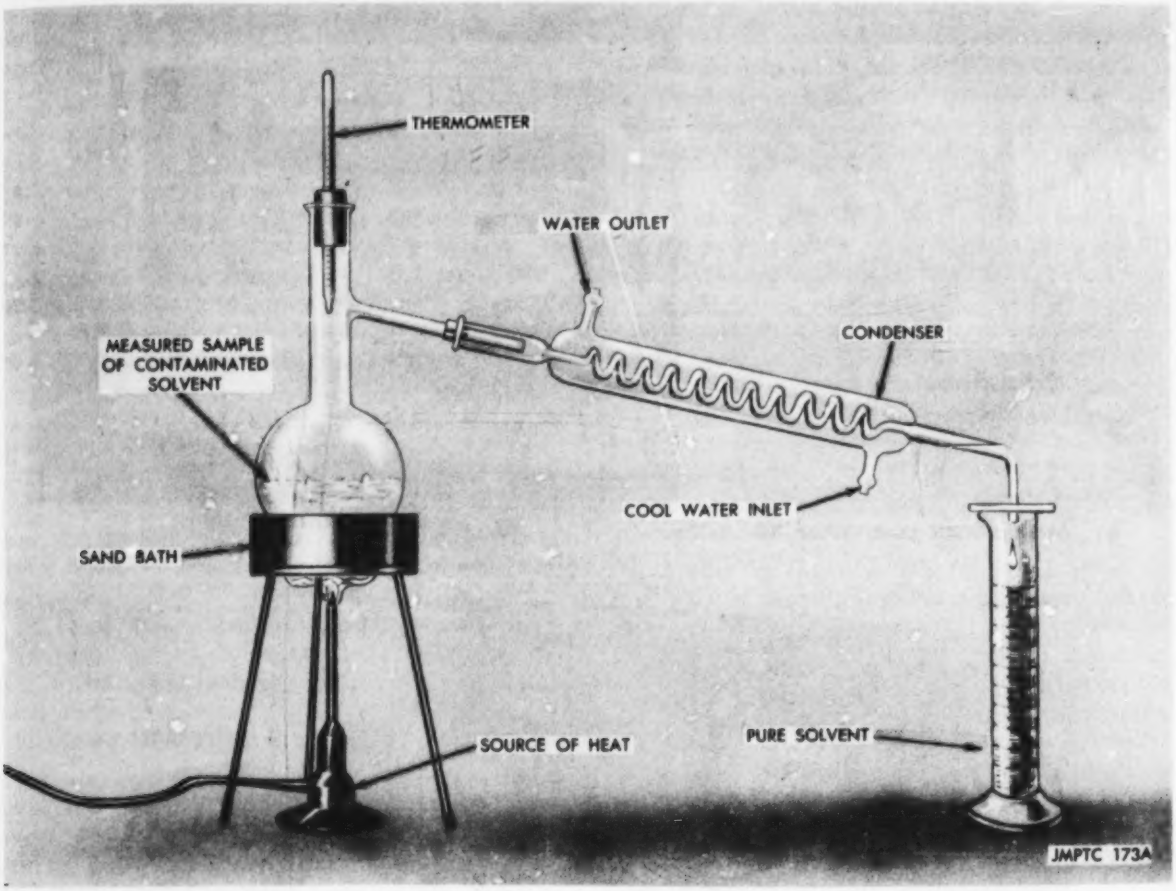


Figure 1-45. Determining sludge content of petroleum solvents.

(c) Examine the wet surfaces of the papers for color change.

(d) Compare color change of universal indicating paper with color chart.

(3) *Interpretation of test results.*

(a) A red tint on the methyl red paper indicates too much acidity.

(b) A blue tint on the red litmus paper indicates too much alkalinity.

(c) If the color change reading of universal indicating paper indicates a reading below pH 6.4 or above pH 8.3 when compared with the chart on the dispenser, this is cause for rejection of the items.

e. *Materials Tests.* Tests to be performed on cleaning materials during cleaning operations are the determination of sludge concentrations in petroleum and chlorinated solvents and the determination of acidity in chlorinated solvents.

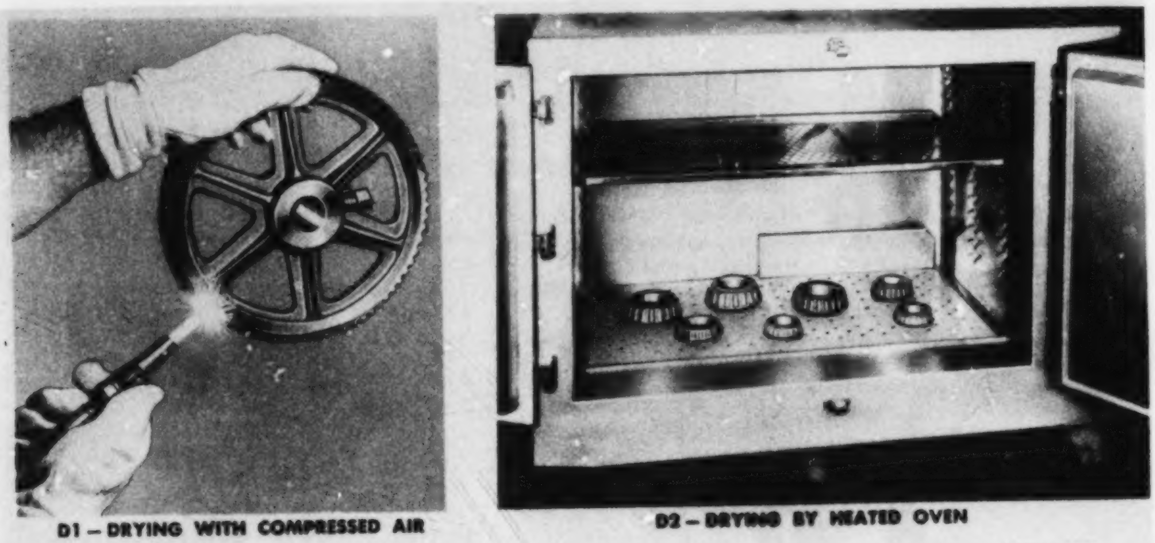
(1) *Sludge content in petroleum solvents (fig 1-45).* Solvents require frequent determinations of the sludge content. When the concentration of the sludge exceeds 2 percent, the solvent should be replaced. The requirements for this test is published by the American Society for Testing and Materials, ASTM D86-78. The sludge content is measured by taking a 100-cubic-centimeter sample of the cleaning solution. This sample is distilled in a laboratory distilling flask. The amount of solvent collected after distillation at the boiling point of the solvent is measured in cubic centimeters. The difference in amount collected from the original sample of 100 cubic centimeters represents the residue of sludge remaining in the distilling flask and is the percent of sludge in the solution.

(2) *Sludge content of chlorinated solvents.* The procedures for determining content of sludge in chlorinated solvents are described in paragraph 1-6*m*.

(3) *Acid condition of chlorinated solvents.* The presence of acid in chlorinated solvents is determined by the procedures in paragraph 1-6*n*.

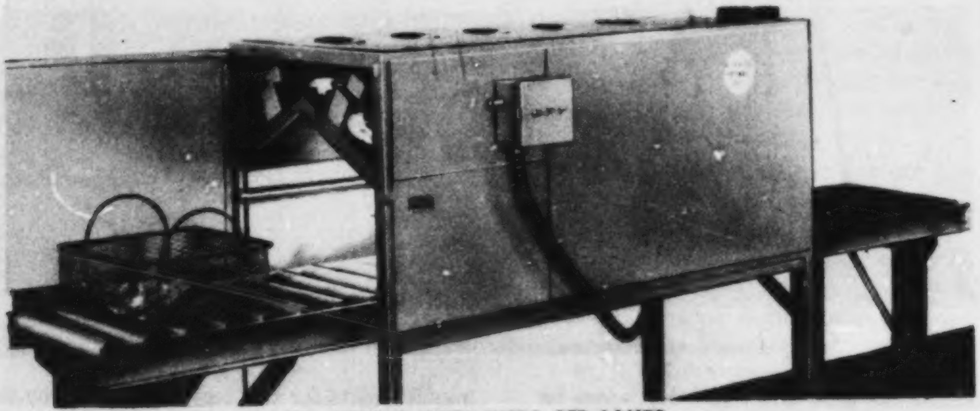
1-15. Drying Procedures

Specification MIL-P-116 directs that immediately after cleaning, items will be thoroughly dried to remove cleaning solutions or residual moisture. The

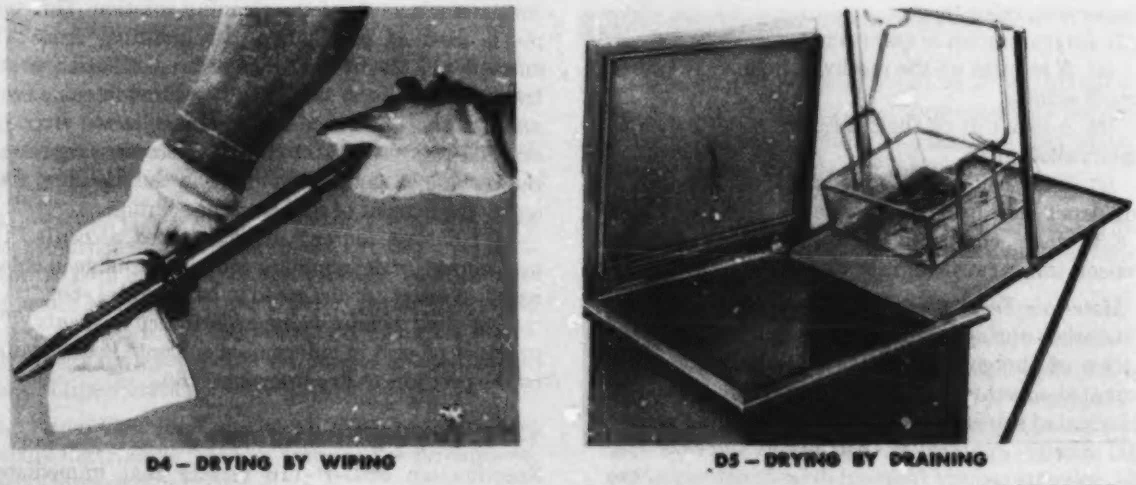


D1 – DRYING WITH COMPRESSED AIR

D2 – DRYING BY HEATED OVEN



D3 – DRYING WITH INFRA RED LAMPS



D4 – DRYING BY WIPING

D5 – DRYING BY DRAINING

JMPC PG 105

Figure 1-46. Drying procedures.

drying may be accomplished by one or more of five different procedures, provided the item is not injured by the procedure.

a. Drying With Prepared Compressed Air (D1, fig 1-46). The steps in drying by compressed air are—

(1) Check the air supply to see that it is free from oil and dirt. Water in the air supply is detected by blowing the air on a polished metal surface or mirror at room temperature and checking for condensation.

(2) Adjust the air pressure to 30 pounds per square inch (maximum to be used).

(3) Apply the compressed air to the surfaces of the item until all traces of solvent have evaporated.

b. Drying With Ovens (D2, fig 1-46). This procedure consists of exposing the items to heated air in a well ventilated and temperature controlled oven. The drying steps are—

(1) Set the temperature of the oven to operate between 270°F and 350°F. Lower the temperature range if the items are liable to damage by the higher temperatures.

(2) Place items in the oven in baskets or on racks.

(3) Circulate and replace the air in the oven by a fan or air jet to hasten drying and remove excess solvent vapors.

(4) Remove items from oven when dry.

c. Drying with infrared lamps (D3, fig 1-46). This is a commonly used procedure for drying. It is adapted to conveyor systems of cleaning and preservation. To increase the effectiveness and hasten drying, items are often blown with compressed air prior to being placed in the infrared cabinet. The steps for infrared drying are—

(1) Place items on conveyor or monorail and pass into infrared cabinet.

(2) Adjust the speed of the conveyor so that items are thoroughly dried, but not overheated.

(3) Set the thermostat so that the temperature of the item is maintained at 160°F. The temperature items will reach will depend upon the length of exposure under the lamps, the number and placement of the lamps, their distance from lamps, and the mass of the item.

d. Drying by Wiping (D4, fig 1-46). This procedure is accomplished only when it is impractical to use any other drying procedure. It is performed as follows:

(1) Use clean lint free, dry cloths to wipe off cleaner residues until surfaces are apparently dry (NOTE, para 1-13c(1)(b)).

(2) Change to fresh, clean, dry, lint free cloths and polish until assured of a thoroughly dried surface.

(3) Discard wiping cloths when they become saturated or soiled by placing them in an all metal container with a closed lid. Empty container at regular intervals as required by safety regulations.

e. Drying by Draining (D5, fig 1-46). When the final step in cleaning involves a petroleum solvent, thorough draining of the solvent is permitted as a drying procedure. Unless otherwise specified, this drying procedure is used only when followed by the application of a cold application solvent cutback preservative. It is not intended for use under methods of preservation when a preservative is not applied. Precautions must be taken to insure that residual films of petroleum solvent will not reduce the effectiveness of the applied preservative compounds. Draining is completed as follows:

(1) Remove the items from cleaning tank and place on rack to drain.

(2) Check item surfaces to assure no residual solvent remains to dilute or interfere with preservative application.

CHAPTER 2

PRESERVATIVES AND THEIR APPLICATION

2-1. Basic Principles of Preservatives Protection

a. Deterioration of Materials. The fact that items have been cleaned and dried does not insure that they will remain free from future contamination. In fact, cleaning may increase the possibility of damage to an item by leaving its surfaces exposed to the direct attack of destructive forces. Attacks by air, water, sunlight, living organisms, temperature changes, and aging occur everywhere. It is known that iron and steel rust; copper, zinc, and similar metals corrode; wood rots and decays; leather cracks and mildews; cork becomes brittle; paper and textiles fade and mildew; food molds and spoils; and other materials change in many ways to reduce their usefulness. This reduction in the usefulness of a material is *deterioration* (fig 2-1). In most cases, deterioration is a chemical change, but it can also be a physical change such as the cold flow or plastic deformation of rubber. The deterioration of a material varies with its composition. Organic materials such as wood, leather, fabrics, rubber, and plastics, are affected by micro-organisms, insects, heat, sunlight, and extremes of humidity. Inorganic materials such as metal, glass, quartz, graphite, and the like, are attacked by chemical actions of gases, water, and sunlight.

b. Corrosion of Metals. The most prevalent form of deterioration to which metal items are subjected is *corrosion.* In the presence of gases found in industrial areas, unprotected metal is attacked. With water absent, the rate of attack is extremely slow, because the film forming on an exposed metal surface by an initial attack, acts as a protective layer and inhibits further corrosion on the base metal. *For example,* oxygen is a protective agent for most metals, despite its attack on all metals at various rates. The action of oxygen on metal usually produces a thin, uniform oxide film that impedes further attack. Pure aluminum, *for example,* will last indefinitely when exposed to air, because it is protected by an adherent and continuous oxide coating that forms immediately on exposure. In the presence of free water and corrosive gases, these protective oxide films change into other less stable oxides, hydroxides, chlorides, and sulfates, which are soluble in water and are thus removed by rain, snow, and sleet, with the result that some of the metal is destroyed. The rate of destruction depends upon such factors as temperature, humidity, evaporation, and sunlight.

c. Electrochemical Corrosion. Electrochemical corrosion takes place when two different metallic components are brought into contact with each other in the presence of water or other nonmetallic conductor (an eletrolyte). The two metallic components plus the electrolyte make up the elements of an electrochemical cell (a battery) and an electrical current will flow accompanied by chemical action. This chemical action is corrosion. That is, one of the metals will dissolve while the other metal will be coated with reaction products. This is due to each metal possessing a different electromotive potential. Where two different metals such as aluminum and steel are coupled together, in the presence of an electrolyte, the potential difference is great enough to cause a flow of current. There is even sufficient potential difference between adjacent crystals of a single piece of impure metal for corrosion to occur when all the conditions are favorable.

d. Galvanic Series of Metals. Various metals differ greatly in their electrical potential and they deteriorate at different rates. The useful metals have been grouped into a series, arranged in the order of the least resistant (anodic) to the more resistant (cathodic). This series, called the Galvanic Series, contains the more commonly used metals ranked from the most susceptible at the top to the least susceptible or more "noble" metals at the bottom. Metals close together in the series show relatively less potential difference than two that are farther apart in the list. This list is presented to provide some assistance in determining the need for applying appropriate protective measures.

(1) Magnesium alloys—all kinds—bare and critical.

(2) Magnesium—bare and critical.

(3) Steel, iron, or any of the alloys thereof except stainless steel—bare and noncritical.

(4) Steel, iron, magnesium, or alloys thereof except stainless steel—bare and noncritical.

(5) Steel or iron plated with chronium, nickel, copper, silver, or tin for other than decorative purposes.

(6) Construction steel (low alloy, high yield point type).

(7) Silver, copper, brass, bronze, beryllium, lead, cadmium, zinc, babbitt and aluminum alloys (all)—bare and critical.

(8) Steel or iron plated with cadmium, zinc, terne, or lead.

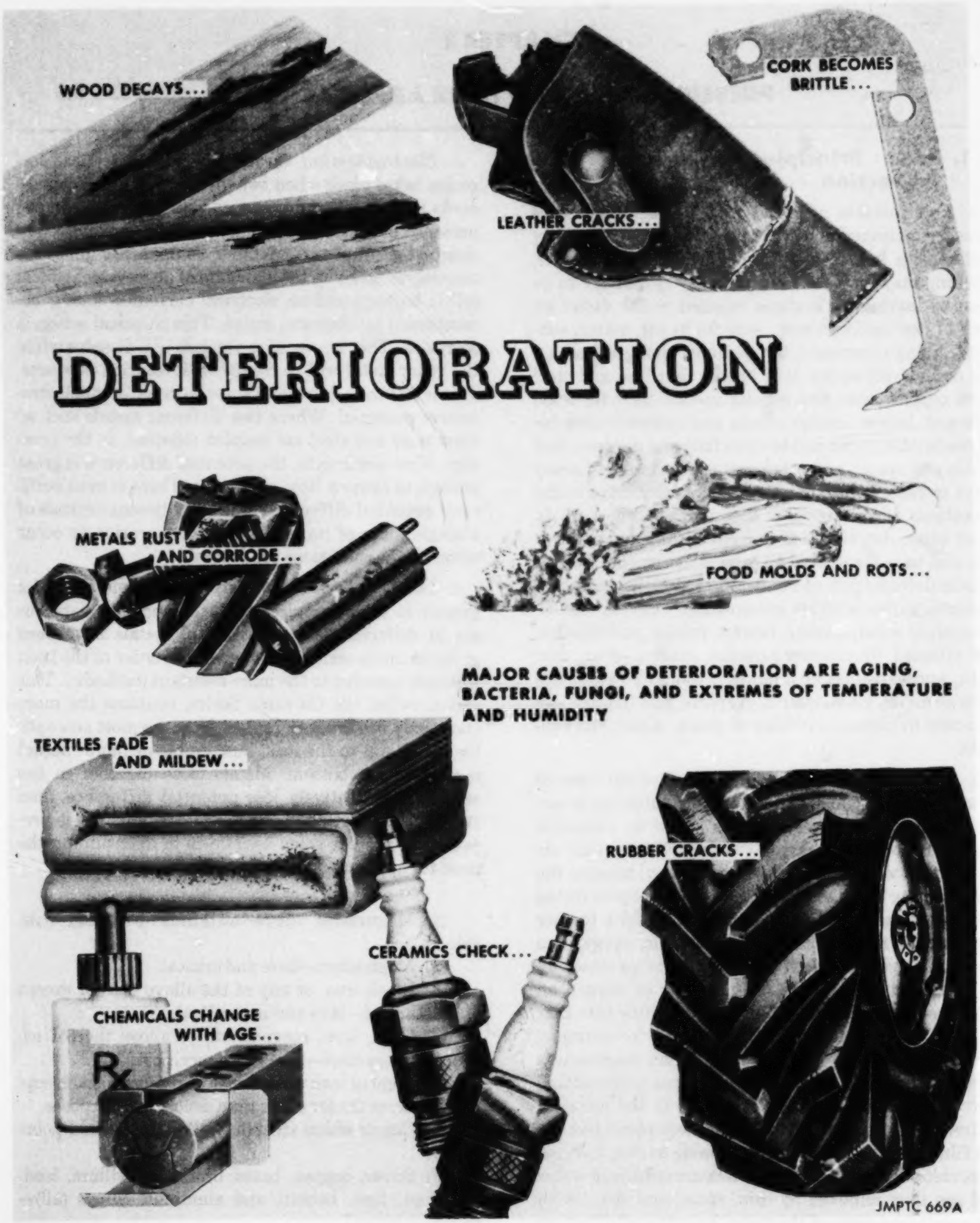

WOOD DECAYS...
LEATHER CRACKS...
CORK BECOMES BRITTLE...
DETERIORATION
METALS RUST AND CORRODE...
FOOD MOLDS AND ROTS...
MAJOR CAUSES OF DETERIORATION ARE AGING, BACTERIA, FUNGI, AND EXTREMES OF TEMPERATURE AND HUMIDITY
TEXTILES FADE AND MILDEW...
RUBBER CRACKS...
CERAMICS CHECK...
CHEMICALS CHANGE WITH AGE...
Rx
JMPTC 669A

Figure 2-1. The cause and effects of deterioration.

(9) Stainless steel, monel metal, alclad aluminum, or titanium—bare and critical.

(10) Silver, copper, bronze, brass, beryllium, lead, babbitt, cadmium, tin and aluminum alloys (all)—bare and noncritical.

(11) Any plating for decorative purposes.

(12) Stainless steel, monel metal, alclad aluminum, and titanium--bare and noncritical.

(13) Solid film lubricants.

(14) Painted surfaces.

NOTE

1. "Bare and critical" refers to uncoated surfaces of items whose use is critical and are of such a nature that any degree of chemical action (in the form of rust, stain, or other corrosion on the item or on any integral surface thereof) renders them unfit for use.

2. The above list is not intended to be a universally applied rating for comparing the corrosion characteristics of specific metals and alloys. It is presented merely to provide to those not familiar with general corrosion characteristics of the more common materials, some assistance in the selection of the method of preservation. In general, the nearer the top of the list a material is found, the more urgent is its need for corrosion protection during storage or overseas shipment.

3. Organic electric insulation, phenolic resinous substances and others containing unsaturated carbon to carbon linkages, such as oil paints and impregnated paper, cause an abnormal attack on cadmium by setting free in the presence of moisture, formic acid, butyric acid, etc. Corrosion of cadmium has been noted when cadmium plated articles have been packaged in direct contact with container materials such as wood or cardboard. Corrosion has been especially severe if the container materials have become wet or have been stored under conditions of high humidity.

e. The Need for Preservative Protection. Since some of the more commonly used metals occur near the top of the series, they are in great need of protection if they are to serve a useful purpose. This protection is achieved by the use of an appropriate preservative applied at the right time.

f. Preservatives Defined. Preservative are materials that are applied to, or come in contact with items to protect them from deterioration resulting from exposure to environmental conditions during shipment and storage. Some preservatives protect items by providing a barrier against moisture, air and other agents of corrosion. These are contact preservatives. Other preservatives protect items by releasing vapors which deposit an invisible protective film on the items. These materials are called volatile corrosion inhibitors (VCI).

g. Preservative Application Criteria. Preservatives should be applied whenever items require protection against deterioration. The composition of some items render them immune to corrosion under ordinary conditions. *For example,* the more resistant metals such as gold, platinum, palladium, and beryllium seldom require a preservative application. Items fabricated from graphite, clay, stone, glass, or ceramics require no preservative coating. Many items susceptible to corrosion can be made less subject to deterioration by the application, at the time of manufacture, of a protective coating which remains an integral part of the *item* during its useful life. Such coatings are permanent preservatives. Many items, however, because of close tolerances, operating characteristics such as rolling, sliding, or bearing surfaces, or other limiting factors cannot be protected with a permanent coating, but must be protected during shipment and storage by temporary preservatives. These materials are applied after the item has been manufactured and must be removed before the item can be used.

2-2. Classification of Preservatives

Preservatives, in addition to being permanent or temporary, are also classified on the basis of the material to be preserved, as preservatives for nonmetals and preservatives for metals. Preservatives for nonmetal items may be either permanent or temporary. Usually, they are applied at the time of manufacture; occasionally, they are applied in the field. This is true of cordage, leather goods, and canvas materials. Nonmetal preservatives are intended to provide protection to items subject to deterioration by hardening, drying, aging, decaying, rotting, and decomposing.

2-3. Permanent Preservatives for Metals

a. Corrosion-Resistant Metals. The most effective means of giving permanent protection to items is to make them from corrosion-resistant metals. There are available a number metals and allous such as corrosion-resistant steel, copper, nickel, chromium, brass, bronze, and beryllium which, under normal conditions of usage, are highly resistant to corrosion. However, the most resistant metals or alloys may be unacceptable because of technical or economic factors. The design engineer may be forced to compromise because of workability, mechanical properties, fabrication problems, availability, or cost. If corrosion resistance is the major design requirement, metals and alloys with superior corrosion resistance should be selected despite higher cost and poor fabrication qualities. While the selection of the fabrication materials is not a direct responsibility of preservation personnel, a knowledge of the corrosion-resistant characteristics of items will assist in the choice of preservatives. For example, corrosion resistant steels quite often require added protection, especially when exposed to salt atmospheres.

b. Metal Coatings. When a corrosion-resistant metal cannot be employed in the fabrication of an item, the next best alternative is to provide a protective metal coating for the corrodible metal used. There are two types of metal coatings that can increase the corrosion resistance of the base metal—

(1) A resistant (cathodic) coating furnishes complete protection of the base metal only if it is impervious to water. If any pores exist in the coating, corrosion of the base metal is accelerated. To increase protection and reduce porosity, the thickness of the coating must be increased. Nearly all the electroplated metals, except zinc and cadmium, are in this category. Of the more resistant metal coatings, nickel plating is the most used to protect steel and iron. A preliminary copper coating is frequently applied, partly because the copper is more cheaply polished than the underlying steel or the superimposed nickel. Copper allso produces better adhesion. Other frequently used coatings are chromium, gold, silver, and tin.

(2) A sacrificial (anodic) coating is one which is attacked first. The coating is destroyed before the base metal is affected. Generally, the corrosion product of the coating provides further protection to the base metal. Some metals like zinc, aluminum, nickel, and copper, when exposed to the atmosphere, form a more or less protective coating which retards further corrosion, since the coating thus formed is insoluble in water. This is not true of iron, however, which continues to rust until completely gone, as the rust continues to dissolve after every exposure to water. The two sacrificial coatings most commonly used are zinc and cadmium.

2-4. Chemical Conversion Coatings

Metals are frequently given corrosion protection by applying chemicals that react with the base metal to form a thin coating which prevents further attack on the metal. These chemicals provide oxide, phosphate, and chromate coatings.

a. Oxide Coatings. There are several processes used to form oxide films on metals at a more rapid rate than would occur in nature. For ferrous metals, these films are produced by heating the metals in various atmospheres, depending on the color or character of the coating desired. In many applications, oxide coatings are more useful for their decorative value than for their corrosion resistance. *Browning, bluing, and blackening* (MIL-C-13924) are processes of this type. They color the metal more than they protect it and are seldom used without an oil or wax coating. For aluminum the aluminum is rapidly oxidized in sulfuric or chromic acid to form permanent oxide coatings. This treatment is referred to as *anodizing* (MIL-A-8625).

b. Phosphate Coatings. The phosphate coatings are similar to oxide coatings. They are produced by immersing the clean metal in a dilute solution of phosphoric acid saturated with the phosphate salt of iron, manganese, or zinc. The metal surface is converted to an insoluble crystalline coating which gives protection against corrosion and serves as an excellent base for further treatments (MIL-C-16232 and TT-C-490).

c. Chromate Coatings. Chromate conversion coatings are applied to items plated with zinc, cadmium, aluminum, magnesium, and other metals. Several procedures are available by which a protective film of chromium salts is produced on the metal platings. The film is formed by simple immersion of the plated item in a chromate or chromic acid solution and sulfuric acid. These chromate coatings applied to zinc and cadmium plated items extend the useful life of such items considerably.

2-5. Vitreous Coatings

Vitreous porcelain or glass enamel coatings consist of a thin layer of glass fused into the surface of the metal, generally iron. Obviously, these coatings have the properties of glass, and variations in their properties are due to the differences in the compositions and physical conditions of the glasses selected. These coatings have been long used for durable and sanitary finishes for iron cooking utensils, refrigerators, and plumbing fixtures.

2-6. Organic Coatings

Organic coatings are widely used to protect surfaces from deterioration. Such coatings are applied as liquids but become solid after application. Included in this group are varnishes, paints, lacquers, and enamels. Organic coatings are essentially barriers and unless care in their application and maintenance is exercised, cracks, pinholes, or other breaks will render the barrier ineffective as a protective coating.

a. Varnishes. A varnish is a combination of drying oil and a fortifying resin, either natural or synthetic. The mixture is thinned with suitable solvents to brushing or spraying viscosity and employed as a clear composition. It dries by oxidation of the oil component.

b. Paints. Originally, this term applied to mixtures of pigments (usually oxides of metals) with a drying oil such as linseed oil. Oil base paints are the oldest type of protective coatings in general use. The term "paint" has now come to mean any combination of pigment-and-liquid-vehicle, such as rubber-base and water emulsions, that are adaptable to brushing, rolling, or spraying, and that dry to a tough, adherent coating.

c. Enamels. An enamel is a pigmented varnish in its strictest sense. Actually, the wide use of fortifying resins in oilbase paints has resulted in the disappearance of any distinction, other than arbitrary one, between paints and enamels. There is currently a tendency to term alkyd-resin-base finishes "quick-dry" enamels to differentiate them from the older, natural resin paints.

d. Lacquers. Originally, a lacquer consisted of one or more selected natural resins dissolved in a rapidly volatile solvent. These compositions were either clear or pigmented. They set to very hard, glossy, nontacky films by solvent evaporation only. Presently, the term is expanded to mean any air-drying or oven-baking type composition, usually, but not necessarily based on nitrocellulose or similar cellulose resins.

2-7. Plastic Coatings

Plastic protective coatings consist of solutions or dispersions of film-forming plastics in organic solvents. These coatings are satisfactory for continuous contact with mild corrosives such as fresh and salt water, some solvents, and some alkalies. Generally, they should be used only for exposure to splash and fumes in the presence of corrosive liquids. There are two basic types of plastic materials employed for protective coatings.

a. Thermoplastic Coatings. A number of thermoplastic coatings have proved useful in protecting metal surfaces in mildly corrosive atmospheres. Of these, polyethylene, styrene copolymers, vinyl resins, and polyvinylidene chloride (saran) are especially valuable.

(1) Polyethylene is not readily soluble in organic solvents; hence, it is applied by the flame-spraying technique and the fusion-bonding technique, *d* below. Flame-sprayed coatings are rough and apt to contain pinholes and other breaks in the coating. However, they have use in military applications involving nuclear and radioactive materials.

(2) Styrene copolymers tolerate the use of considerable inert filters and have outstanding adhesive characteristics. They may be pigmented to make almost any color. Aqueous dispersions of styrene copolymers are finding extensive use as water paints and are available in many colors.

(3) Vinyl resins have been compounded to be highly resistant to alkalies, corrosive salts, certain solvents, and acids. They are used in the protection of metal against splash and fumes of corrosive chemicals, and for coating objects which are to be continuously immersed in fresh or salt water.

(4) Epoxy coatings are resistant to acids, alkalies, and some solvents. They adhere well to a wide variety of surfaces, and their impact resistance can be made superior to that of phenolic coatings by the addition of flexibilizers.

b. Thermosetting Coatings. Several of the thermosetting types of plastics are being used as corrosion-resistant coatings.

(1) Polyesters blended with styrene can be compounded to yield a protective coating with good chemical resistance. Polyester coatings may be colored and may be applied by brushing, roller coating, or spraying.

(2) Urea-melamine resins are used primarily as baked coatings. When applied as organic solutions and baked at temperatures between 200° and 350°F., hard, light colored, brittle films are produced.

(3) Phenolic coatings have been used for many years for preventing iron contamination to liquids stored in drums and tanks. They are applied as liquid resins dissolved in alcohol and dried and baked at temperatures near 300°F.

(4) Epoxy coatings are resistant to acids, alkalies, and some solvents. They adhere well to a wide variety of surfaces, and their impact resistance can be made superior to that of phenolic coatings by the addition of flexibilizers.

c. Rubber-Type Coatings. A number of rubber-type coatings are employed as protective coatings.

(1) Chlorinated rubber (natural rubber treated with chlorine) forms a plastic material which has excellent adhesion to many surfaces and is resistant to many corrosives. It has low resistance to heat and light. By blending it with other resins and plasticizers, its brittleness is overcome to a great extent.

(2) Chlorosulfonated polyethylene is produced by exposure of polyethylene to chlorine and sulfur dioxide. This increases the solubility of polyethylene in several solvents. The dissolved polyethylene gives excellent adhesion characteristics. When compounded with litharge, it can be heat cured. It has excellent chemical resistance and can be pigmented to produce a wide choice of colors.

(3) Chloroprene (Neoprene) can be dispersed in organic solvents and can then be applied by brush or spray. It has excellent resistance to oils, sunlight, heat and ozone, and high retention of resilience upon aging. This combination of properties makes it ideal for use as a heavy-duty protective coating. Chloroprene coatings with high solid content yield heavy films which adhere well to chlorinated-rubber primed surfaces.

d. Fusion-bonded plastic coatings. The fusion-bonding of powdered plastics to the surfaces of objects that can be heated to the melting point of the plastic is a new technique for applying protective and decorative plastic coatings. Many plastics which have not been used previously because of their insolubility as protective coating materials can now be used to provide excellent protection against acids, alkalies, and corrosive liquids. Plastics such as polyethylenes, polyesters, epoxies, vinyls, nylons, and saran can now be obtained in finely divided-powdered form in many colors. The powdered plastic is placed in a fluidizer (fig 2-2) consisting of a tank having an upper and lower section divided by a porous plate. Air or gas forced up through the porous plate causes the powder to vibrate as if it were a boiling liquid. The coating process consists of dipping a preheated item for a few seconds in the fluidized powdered plastic. The powder, upon coming in contact with the heated item, is melted and forms a smooth plastic film over the surface of the item. The coated item is then placed in an oven for curing to set the film.

2-8. Preservatives for Nonmetals

Since the preservatives for nometals include a wide variety of materials, in most instances intended for specific applications, their use is limited to the instructions contained in contracts, specifications, or special processing directives and manuals. Examples of some of the common nonmetal preservatives are electrical circuit preservatives, leather preservatives, and textile preservatives.

a. Electrical Circuit Preservatives. These compounds are used to protect electrical and electronic equipment against the effects of fungus and moisture. It is generally desirable to design equipment so that the use of the products is not necessary; however, when equipment is not so designed, these materials are suitable for providing the necessary protection.

(1) *Moisture and fungus resistant varnish (MIL-V-173).* This varnish is used for the overall protection of communications and electronic equipment against the effect of moisture and fungus attack on the performance of the equipment. It may be applied by spraying, dipping, or brushing and must be used in conjunction with supplementary specifications stating the method of application of the varnish and the treatment of the equipment to receive it.

(2) *Waterproofing, electrical ignition varnish (MIL-V-13811).* This material is a clear (unpigmented) compound intended primarily for use in protecting electrical circuits and engine parts of internal combustion engines, used on military motor vehicles and other automotive equipment. This compound can be applied by spraying, dipping, or brushing. The resulting coating dries to a hard, flexible film in about 8 hours. The solvents used in this material have a low flashpoint (75°F), and safety precautions against fire must be taken. It must not be applied to heated surfaces. This compound should be stored in tightly sealed containers.

b. Leather Preservatives. These compounds are used on leather items to give them resistance to cracking, mildew growth, and water penetration. They are expected to preserve the original qualities of leather and improve the qualities of leather items that have been in use.

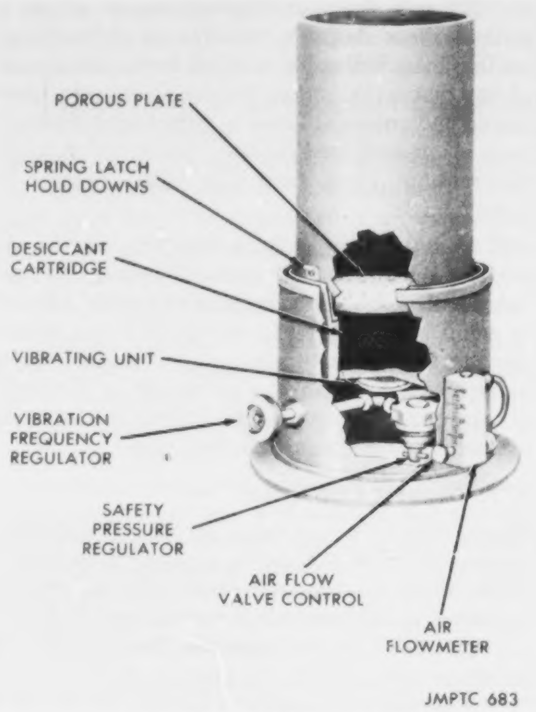


Figure 2-2. Fusion-bonding fluidizer.

(1) *Mildew preventive leather dressing (O-L-164).* This dressing comes in two types: an emulsifiable type and a solvent type.

(*a*) The emulsifiable type is prepared by adding 1 gallon of the base material to 5 gallons of water. The items to be treated must be thoroughly cleaned in warm (not over 100°F) soapy water. After rinsing and draining for 30 minutes, the items are immersed in the compound and agitated for 10 minutes. For a few items, the undiluted compound may be applied with a soft bristle brush, felt dauber, or soft cloth.

(*b*) The solvent type of leather dressing is used as received with no dilution necessary. Items must be cleaned in warm (not over 100°F) soapy water, rinsed and drained for about 5 minutes. The items are then immersed in the compound for about 2 minutes. The treated leather must be allowed to dry thoroughly in the open air before wearing.

(2) *Handling.* These compounds must be handled with due regard to health. Application of these materials must be made in a well ventilated area. Skin contact and the breathing of the fumes should be avoided. The hands must be washed thoroughly in cool water and soap after application. Treated materials must be thoroughly aired and dried before allowing them to come in close contact with the skin. The compounds

should not be used on leather products which will come in prolonged contact with the skin.

c. Textile Preservatives. These consist of several complex chemical treatments which are intended to give a high degree of mildew resistance to fabrics, wool felt, rope, thread, twine, and other natural fibers. The chemical agents used in these treatments are capable of limiting the growth of mildew and fungus. Most of these processes should not be applied to materials which will come in frequent and close contact with a person's skin during use. They should not be used on materials which will be coated with, or come in contact with natural rubber. They will cause an undesirable reaction with the rubber. In preparing colored materials, allowance must be made for the effects the process may have on the colors. Many textiles are also protected by the use of vapor type preservatives such as naphthalene or paradichlorobenzene (O-P-99) which repel insect attack.

d. Linseed Oil. Linseed oil can be obtained raw (TT-L-215) or kettle boiled (heated in the presence of metallic drying compounds) (TT-L-190). Aside from its use in the manufacture of, and thinning of paints and varnishes, linseed oil is used to preserve wooden gun stocks and similar wooded items, and to treat the inner surfaces of chests and lockers in hot, humid, or dry areas. For gun stocks, it is prepared by mixing 1 gallon of volatile mineral spirits paint thinner with 6 gallons of raw linseed oil (kettle boiled if faster drying is desired) and 2 percent of fungicide. Any wiping cloths used while applying linseed oil should be disposed of immediately after use to avoid fire by spontaneous combustion.

e. Castor Oil, Technical (JJJ-C-86). Castor oil is used as a preservative on hydraulic brake systems and as a leather dressing.

2-9. Temporary or P-Type Metal Preservatives

d. Need for P-Type Preservatives. Many finished metal items require a preservative coating that is easily removed, and yet will not rub off or abrade. Attempts were made to use lubricating oils for this purpose, since oil and water do not normally mix. It was found that lubricating oils, being lighter than water, and with less attraction to the metal surface, were soon displaced by water. A number of protective, removable petroleum base compounds have been developed with characteristics for specific preservation needs. By adding ingredients with water displacing compounds and inhibiting qualities to lubricating oils, greases, and hydraulic fluids, several temporary preservatives have been developed. These compounds have different consistencies and require different methods of application.

b. P-Type Metal Preservative Groups. For convenience, the preservatives listed in Specification MIL-P-116 are classified according to composition and application requirements into four groups: thin film, solvent cutback, cold application; petrolatum base, hot application; rust inhibiting oils, cold application; and special purposes, cold application (table 2-1).

Table 2-1. P-Type Metal Preservatives Group

Group 1 *Thin film, solvent cutback, cold application*	Group 2 *Petrolatum base, hot application*	Group 3 *Oils, rust-inhibiting, cold application*	Group 4 *Special purpose, cold application*
p-1, p-2, p-3, p-19 p-21	p-6	p-7, p-9, p-10, p-15, p-17 p-20	p-11, p-14, p-18

(1) *Group 1.* The thin film solvent cutback, cold application preservatives contain 40 to 60 percent petroleum solvent, which evaporates, leaving a thin protective film. P-1 is black in color, asphaltic in nature, and is suitable for long-term outdoor or indoor service. P-2 and P-3 are amber in color and are intended for short-term outdoor and long-term indoor exposures. P-2 is oil miscible and P-3 is water displacing. P-19 is a transparent nontacky film. P-21 is the same as P-3 but with the additional requirement that it is removable with hot water or low pressure steam.

(2) *Group 2.* P-6 is the one petrolatum base, hot application preservative currently in use by the military. It consists of petroleum plus inhibitors. It is made by adding oils of high viscosity to the petrolatum base. As the consistency decreases, the ease of application increases; but the degree of protection decreases. P-6 has a moderate resistance to rubbing, can expand and contract with the metal, and can self-heal some "rub-off." It is applied by brushing or swabbing at room temperature or by dipping in the molten state. It is used for preservation of antifriction bearings and for used on machined surfaces for which a protective material that is brushable and easily removable at room temperature is required.

(3) *Group 3.* Rust inhibiting oils, cold application, consist of petroleum oils to which rust inhibitors have been added. These oils are used where the petrolatum base types are unsuitable or difficult to apply; *for example*, in oil lubricated bearings, hydraulic systems, turbines, and gearcases. These oils drain off or are removed by wick action; thus greaseproof wraps must be used to keep the oils within the package. Examples of these oils are P-7, P-9, P-10, P-15, P-17, and P-20. P-9 is also water displacing.

(4) *Group 4.* Special purpose, cold application compounds are made for specific use and should be applied to those items for which they are intended. *For*

example, P-14 is intended for food handling machinery, and P-18 (Volatile Corrosion Inhibitor) is used for protecting ferrous metals where oils and greases are undesirable.

c. *P-Type Metal Preservatives and Their Use.* The description, characteristics, physical properties, uses, application, and removal of the P-type preservatives are presented in table 2-2. The flashpoints are included to indicate possible fire hazards, and the pour point indicates possible climatic problems.

2-10. Operational Lubricants and Temporary Preservatives Other Than P-Type

There are a number of preservatives for temporary use not listed in MIL-P-116, some of which have been developed for specific uses. These preservative or corrosion preventing materials are listed in table 2-3. The flashpoint and flow point values, where available, have been listed to indicate possible fire hazards and usage in cold climate situations.

2-11. Application Requirements

Most temporary preservatives are oily or greasy in nature, and vary greatly in chemical composition and consistency; therefore, they cannot be used indiscriminately on all kinds of materials. They may even destroy the usefulness of an item due to the difficulty of removal. An example will be the application of a hard-drying P-type preservative to a typewriter. A preservative may penetrate into unwanted areas and cause swelling or decomposition of the material, or reduce its electrical conductivity. The criteria for preservative application have been established with some exceptions for specific situations.

a. *Basic Application Requirements.* Petroleum or P-type preservatives are applied to those metal surfaces on which corrosion in any form, such as oxides, sulfides, and verdigris, would impair the usefulness of the item or assembly, except under the conditions discussed below. The type of preservative is usually specified in procurement documents or processing specifications. In the absence of specific instructions, the choice of preservatives is made from those listed in Specification MIL-P-116, P-1 through P-21, as shown in table 2-2. Care must be taken that the preservative selected will not damage the mechanism, structure, or function of the item, either when applied, in use, or during removal.

b. *Exceptions to Basic Application Requirements.* P-type preservatives are *not* applied to surfaces which are protected with solid film lubricants, vitreous, plastic, prime, or paint coatings. They are *not* normally used on noncritical metal surfaces that are inherently resistant to corrosion, brass, bronze, or other corrosion resistant metals and alloys. P-type preservatives are *not* applied to noncritical items that have been chromium, silver, nickel, cadmium, zinc, or tin plated or coated except cadmium plated or coated items packaged in nonventilated containers together with organic coated items or insulated electrical items require application of a preservative. Oily type preservatives are *not* applied to items that are vulnerable to damage by the petroleum ingredients, such as those fabricated from textiles, cordage, plastics, mica, rubber, paper, felts, leather and leather products, or prelubricated bushings. These preservatives are not applied to certain types of electrical and electronic components, distributor rotors, circuit breakers, uses, switches, resistors, and rectifiers. Finally, P-type preservatives are not applied to any items which would suffer damage to the mechanism or structure, or where malfunction or unsafe operational conditions would result from the application or removal of the preservative.

c. *Preservative Selection Criteria.* To choose the type of preservative to be applied to a specific item, a number of factors must be considered. First it is the characteristics of the item. The composition, surface finish, complexity of construction, size, and shape must all be evaluated before a preservative is applied. Second is the characteristics of the preservative. Some preservatives are hard-drying and difficult to remove. Some are thin and drain off too rapidly under high temperatures. Some require heating for application, while others can be applied cold. Third is the extent of protection desired. If the item is to be used within a relatively short period of time, only a light, temporary preservative is necessary; but if the item is to be shipped overseas, or must remain in storage for several years then a more persistent protective coating is demanded. Finally, the requirements of the user must be considered. If it is necessary to spend hours in the field attempting to remove hard-drying and hard-setting preservative, without adequate cleaning equipment, the outcome of a military engagement may be influenced by such delay. A light preservative in combination with a waterproof or water-vaporproof pack may be preferred for certain items, rather than using a hard film preservative (fig 2-3 and table 2-2).

(1) *Item composition.* The composition of an item determines whether it can be preserved and, if so, what kind of preservative is used. Generally, metal items are preserved with any of the P-type compounds. The exceptions are when there is a possibility of chemical reaction between the metal and certain additives in the preservative. For instance, some highly finished copper or brass, or cadmium or zinc plated items, have been stained by preservatives containing sulfur or phosphorous ingredients. Usually, P-type preservatives are not applied to nonmetal items made of glass, rubber, leather, cork, paper, fabrics, or plas-

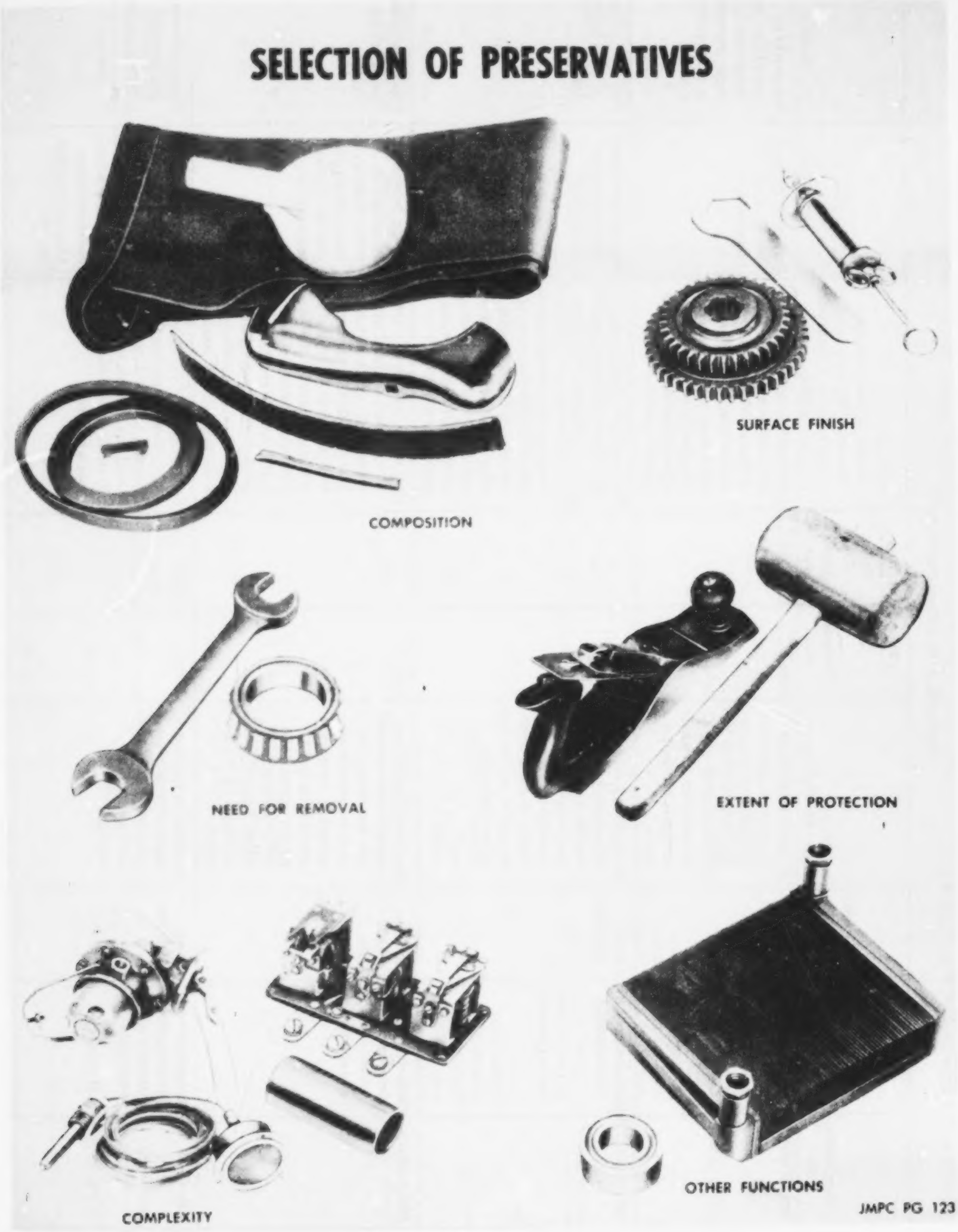

SELECTION OF PRESERVATIVES
SURFACE FINISH
COMPOSITION
NEED FOR REMOVAL
EXTENT OF PROTECTION
OTHER FUNCTIONS
COMPLEXITY
JMPC PG 123

Figure 2-3. Item characteristics which determine the selection of preservatives.

Table 2-2. P-Type Metal Preservatives

					Physical properties				
P-No.	Specification No.	Specification title	Grade, type or class	Description	Flashpoint min.	Melt or flow point min.	Uses	Application	Removal
P-1	MIL-C-16173	Corrosion preventive compound, solvent cutback, cold application.	Grade 1, Hard film.	An asphalt compound dissolved in petroleum solvent which dries to a hard thin-paint-like film upon evaporation of solvent. Film dries hard enough to handle in 4 hours.	100° F.....	175° F.....	Protection of noncritical metal items that are stored outdoors or where a "dry-to-touch" film is desired. Should not be used on items requiring removal of film for operation. Used on bolts, chains, bale hooks and similar items.	Dipping, spraying or brushing at room temperature.	Not usually required. Can be accomplished by vapor degreasing or with petroleum solvents.
P-2	MIL-C-16173	Corrosion preventive compound, solvent cutback, cold application.	Grade 2, Soft film.	An amber colored compound diluted with solvent that remains soft upon evaporation of the solvent. Mixes readily with oil. Must be applied cold because of low flash point.	100° F.....	....	Extended under cover protection to exterior surfaces of machinery, instruments, bearings or material with or without use of supplementary barrier materials, for outdoor protection of material for limited periods where metal temperatures do not reach levels which produce prohibitive flow of corrosion preventive film.	Dipping, spraying or brushing at room temperature.	Petroleum solvents or vapor degreasing.
P-3	MIL-C16173	Corrosion preventive compound, solvent cutback, cold application.	Grade 3, Water displacing. Soft film.	A solvent dispersed compound which deposits a thin nondrying film upon evaporation of solvent. It contains ingredients having a greater attraction to metal surfaces than water, thus giving water displacing characteristics.	100° F.....	....	Used where fresh or salt water must be displaced from corrodible surfaces and the corrosion prevented or stopped; for protecting interior surfaces of machinery; instruments, or material under cover for limited periods and for protecting critical bare steel or phosphated surfaces for extended periods when satisfactorily packaged.	Dipping, brushing, spraying of exterior; flushing, filling or slushing of interiors at room temperatures.	Vapor degreasing or petroleum solvents.
P-6	MIL-C-11796	Corrosion preventive compound, petrolatum, hot application.	Class 3. Soft film.	A petrolatum base corrosion preventive compound which leaves a soft greasy film setting.	350° F.....	135° F.....	Preservation of antifriction bearings; for use on machined surfaces for which a protective material that is brushable and easily removable at room temperature is required.	Applied either by brushing or swabbing at room temperature, or by dipping in the molten state at temperatures not to exceed 180° F.	Vapor degreasing or petroleum solvents.

Table 2-2.—Continued

P-No.	Specification No.	Specification title	Grade, type or class	Description	Physical properties		Uses	Application	Removal
					Flashpoint min.	Melt or flow point min.			
P-7	MIL-L-3150	Lubricating oil, preservative, medium.	One grade only.	A clear, highly refined lubricating oil with same viscosity as SAE No. 30 motor oil to which sufficient inhibitor added to give corrosion protection without causing separation in storage.	300° F min.	20° F (pour point max.	For lubricating and preserving internal surfaces of machine assemblies (other than internal combustion engines), for artillery and small arms, transmissions, differentials, fuel tanks. Used as temporary preservative on items and equipment awaiting processing for long term storage and for maintaining supplies and equipment in the reserve fleet.	Applied at room temperature by any applicable method except fogging.	Vapor degreasing or petroleum solvents.
P-9	VV-L-800	Lubricating oil, general purpose, preservative (water displacing low temperature).	One grade only.	A highly refined, light, low viscosity oil containing rust inhibiting additives. Its viscosity is similar to SAE 5 oil.	275° F min.	−70° F (pour point max.).	For use in lubricating and protection against corrosion of certain small arms, automatic weapons, fuse mechanisms, components of internal combustion engines, and whatever a general purpose low temperature.	Any method of room temperature. Available in gas-pressurized containers for use in areas difficult to preserve by other existing procedures.	Petroleum solvents or vapor degreasing.
P-10	MIL-L-21260	Lubricating oil, internal combustion engine, preservative and break-in.	Type I, Grade 10 (Light viscosity).	A petroleum product compounded with additive material. Viscosity equal to SAE No. 10.	360° F	−20° F (pour point max.).	For preservative and break-in use in reciprocating spark-ignition and compression-ignition engines, in all types of ground equipment, at temperatures above −10° F, operating at output levels up to 150 p.s.i., BMEP. Also to protect engine parts from deterioration during shipment and storage. Should be used as a factory-fill and break-in oils for all new and rebuilt engines. Oils are also operational and need not be drained till first scheduled oil change.	Any method at room temperature.	Petroleum solvents. Removal before use not generally required.
	MIL-L-21260	....	Type I, Grade 30.	Medium viscosity oil with viscosity equal to SAE Grade 30.	390° F	0 (pour point max.).			
	MIL-L-21260	....	Type I, Grade 50.	Heavy viscosity oil with viscosity equal to SAE Grade 50.	400° F	15° F (pour point max.).			

Table 2-2.—Continued

P-No.	Specification No.	Specification title	Grade, type or class	Description	Physical properties		Uses	Application	Removal
					Flashpoint min.	Melt or flow point min.			
	MIL-C-6529 (For aeronautical applications)	Corrosion preventive aircraft engine.	Type I, Concentrate material.	A concentrate-material used as an additive with any lubricating oil qualified under MIL-O-6081 or MIL-L-6082 *in proportion* of 1 part concentrate to 3 parts lubricating oil. May also be added to MIL-L-22851.	400° F	10° F (pour point max.).	For use as corrosion-preventive lubricant for reciprocating engines when blended with MIL-L-6082 oil, and when blended with MIL-L-6081 oil, for turbojet engines requiring MIL-L-6081 oil. May also be blended with MIL-L-2285 oil.	Any method at room temperature.	Petroleum solvent. Removal is generally not required.
	MIL-L-6529	. . . .	Type II, Ready mixed material for reciprocating aircraft engines.	A ready mixed material for reciprocating engines, a blend of type I, and MIL-7-6082 or prepared directly from MIL-L-6082 and additives.	. . . .	. . . .	For use in preserving reciprocating engines and equipment.		
	MIL-C-6529	. . . .	Type III, Ready mixed material for turbojet aircraft engines.	A ready mixed material for jet aircraft.	. . . .	. . . .	For use in preserving turbojet engines.		
	MIL-C-8188	Corrosion preventive oil, gas turbine engine, aircraft, synthetic base.	Grade A, High temperature oil. Grade B, Low temperature oil.	Transparent corrosion preventive oil.	350° F	−75° F	For preservation of turboprop and turbojet engines using MIL-L-7808 oils. Use should not exceed 20 hours as an aircraft engine lubricant. Will be used for both preervation and final acceptance runs of aircraft engines requiring the use of specification MIL-L-7808 oils.	Filling	Draining.

Table 2-2.—Continued

P-No.	Specification No.	Specification title	Grade, type or class	Description	Physical properties		Uses	Application	Removal
					Flashpoint min.	Melt or flow point min.			
P-11	MIL-G-23827 (For aeronautical applications).	Grease, aircraft and instrument, gear and actuator screw.	One grade only.	A smooth homogeneous mix-gelling agent and a low temperature lubricant. Functional as a grease between—65° and 160° F.	....	....	For ball, roller and needle bearings, gears and on sliding and rolling surfaces of such equipment as instruments, cameras, electronic gear and aircraft control systems during high and low temperature operations.	Brush, swab or grease gun at room temperature.	Toluene, benzene or hot SAE oil followed by solvent. Removal not generally required.
	MIL-G-10924	Grease, automotive and artillery.	One grade only.	A smooth homogeneous mixture of material or synthetic oil or combination thereof with a gelling agent stabilized to give low and high temperature performance between—65° F and 225° F.	....	....	For lubrication of automotive and artillery equipment operating over an ambient temperature range of minus 65° F (-54° C) to 225° F (107° C).	Brush, grease gun or swabbing at room temperature.	Same as above grease.
	MIL-G-81322	Grease, aircraft, general purpose wide temperature range.	One grade only.	The grease shall consist essentially of a wide temperature range liquid lubricant and a high melting point gelling agent.	....	....	A general purpose grease in applications where operation at temperatures as low as —65° F (—54° C) and as high as 350° F (117° C) may be required. It is specifically designed for wheel bearings in internal brake wheel assemblies, anti-friction bearings, gear boxes, and plain bearings.		
P-14	MIL-C-10382	Corrosion, preventive, petrolatum, spraying application for food handling machinery and equipment.	One grade only.	A smooth uniform mixture of petrolatum wax, lanolin and additives in petroleum solvent. The mixture must be sprayable at room temperature to produce a thin, easily removable film on drying.	100° F (38° C)	150° F (66° C)	For use on food handling machinery and equipment. The residual material after evaporation shall be harmless if inadvertently ingested by personnel.	Spraying at room temperature.	Hot water 160° F (71° C)

Table 2-2.—Continued

P-No.	Specification No.	Specification title	Grade, type or class	Description	Physical properties		Uses	Application	Removal
					Flashpoint min.	Melt or flow point min.			
P-15	....	Hydraulic preservative oil. These oils have not been listed in MIL-P-116 because of variation in system requirements.	Hydraulic preservatives used will be subject to approval of procuring agencies.						
P-17	MIL-L-6085	Lubricating oil, instrument, aircraft, low volatility.	One grade only.	A synthetically compound oil with additives to give antioxidation and corrosion protective properties. Has a very low evaporation rate and can remain fluid at −70° F.	365° F... (185° C)	70° F (21° C) (Pour point max)	For use in aircraft instruments, electronic equipment, or where a low evaporation oil is required for both high and low temperature application, and where oxidation and corrosion resistance are desired.	Applied by dipping, spraying or squirt oiler.	Removal not required but if necessary solvent rinse should be sufficient.
P-18	MIL-P-3420	Packaging materials, volatile, corrosion inhibitor, treated, opaque.	Type I for general application.	Chemical compound which inhibits corrosion by releasing vapors within a package. The compounds are impregnated or coated to a carrier. The treated carriers include: Kraft paper, aluminum foil, Grades A or C of MIL-B-	....	....	For general application to the protection of metal surfaces. Shall not be used to protect assemblies containing optical systems, equipment embodying precision moving parts with close tolerances, or electrical contacts.	Wrapped around item or as bore tubes inserted in interiors.	Remove barrier or bore tubes from item.
	MIL-P-3420	....	Type II for limited application.	Same as Type I fiberboard and asphalt laminates.	....	....	Type II (MIL-P-3420) may be used the same as Type I, except it will not be used for the preservation of nonmetallic components or where plastic barrier packaging materials are involved.		
	MIL-F-22019	Film, transparent, flexible, heat-sealable, volatile corrosion inhibitor treated.	....	A transparent, flexible, heat-sealable film treated with a volatile corrosion inhibitor.	....	....	For use as a material for packages where transparency is desired to facilitate inspection of the item without disturbing the package. Also intended for shipboard use.	Applied as a barrier material in accordance with applicable submethods set forth in MIL-P-116.	

Table 2-2.—Continued

P-No.	Specification No.	Specification title	Grade, type or class	Description	Physical properties		Uses	Application	Removal
					Flashpoint min.	Melt or flow point min.			
		Note. Packages fabricated from this material are intended mainly for short-term protection of items. Short-term protection is limited to 24 months between time of packaging and use.							
	MIL–B–22020	Bags, transparent, flexible, sealable, volatile corrosion inhibitor treated.	…………	A bag fabricated from material conforming to specification MIL–F–22019.	………	………	Same as above. *Note.* Maximum weight of the content in each bag should not exceed 5 pounds.		
	MIL–I–22110	Inhibitors, corrosion, volatile, crystalline.	Type I For general application (low volatility).	A solid form of vapor corrosion inhibitors which transport their vapor to a metal surface.	………	………	For use as a preservative for ferrous aluminum, aluminum-base alloys, and components containing zinc plate, cadmium zinc-base alloys, magnesium-base alloys, lead-base alloys, and alloys of other metals (including solders and brazing alloys, having less than 30% of zinc and 9% of lead). Direct contact with non-ferrous metals, except aluminum and aluminum-base alloys, shall be avoided. Direct contact with non-metals shall be avoided, unless the specific inhibitor has passed the compatibility test specified in MIL–I–8574.		
	MIL–I–22110	…………	Type II, For limited application (high volatility).	Same as Type I ………	………	………	Has the same use as Type I, except that it must be used in sealed water vaporproof containers.		

Table 2-2.—Continued

P-No.	Specification No.	Specification title	Grade, type or class	Description	Physical properties		Uses	Application	Removal
					Flashpoint min.	Melt or flow point min.			
P-19	MIL-C-16173	Corrosion preventive compound, solvent cutback, cold-application.	Grade 4, Transparent, nontacky film.	Transparent during protective life of film. Solvent-dispersed, amber colored, nontacky film.	100° F... 38° C	....	General purpose indoor and limited outdoor preservation of corrodible metals, with or without an overwrap, and where handling, stacking, and counting requires a tackfree coating. Where a transparent coating is required in addition to protective qualities, where there is no requirement for miscibility with lubricating oil, and where ease of removal with petroleum solvent is important.	Dipping, and brushing at room temperature.	Petroleum solvents or vapor degreasing.
P-20	MIL-I-23310 (For Navy use)	Inhibitors, corrosion, volatile, oil type.	Grade 1, Low viscosity oil.	A volatile, oil type material in petroleum-base oil.	300° F... 148° C	-20° F.. -29° C	Use as a preservative in "closed" systems constructed essentially of ferrous alloys, with components containing aluminum and aluminum-base alloys.	Fogging	Removal from combustion chamber not required.
	MIL-I-23310	....	Grade 2, Medium viscosity oil.	Same as grade 1	300° F... 149° C	0° F..... -18° C			
	MIL-P-46002	Preservative oil contact and volatile corrosion inhibited.	Grade 1, Light viscosity oil.	A volatile corrosion inhibited lubricating oil.	240° F... 116° C	-50° F.. -44° C	Used in the preservation of inclosed systems where the volatile components will provide protection above the oil level.	Filling. *Note.* This oil is not effective unless an adequate reservoir of oil can be maintained. A minimum of 0.15 quart for Grade 1 and 0.25 quart for Grade 2 should be utilized for each cubic foot of area to be protected.	
	MIL-L-46002	....	Grade 2, Medium viscosity oil.	Same as grade 1	250° F... 121° C	-10° F.. -22° C	May also be effectively utilized as a contact preservative. Is not intended for use as an operational preservative oil and should not be used in applications where magnesium, cadmium plated, or rubber components are present.		
P-21	MIL-C-16173	Corrosion preventive compound, solvent cutback, cold application.	Grade 5, Pressure steam removable film.	A solvent dispersed corrosion preventive compound which deposits a thin, easily removable film after evaporation of the solvent.	100° F... 38° C	....	Used where fresh or salt water must be displaced from corrodible surfaces; for protecting interior surfaces of materiel under cover for limited periods, and for protection of critical bare	Dipping, brushing, spraying of exterior surfaces and flushing, filling, or slushing of interior surfaces at room tem-	Vapor degreasing, solvent, hot water, or low pressure steam.

Table 2-2.—Continued

P-No.	Specification No.	Specification title	Grade, type or class	Description	Physical properties		Uses	Application	Removal
					Flashpoint min.	Melt or flow point min.			
							steel or phosphated surfaces for extended periods when packaged with satisfactory barrier materials. Used in lieu of grade 3, MIL-C-16173, where chemical "boilout" cannot be used for removal.	perature (40° F or higher).	

Table 2-3. Operational Lubricants and Temporary Preservatives Other Than P-Type

Specification No.	Specification title	Grade, type or class	Description	Physical properties		Uses	Application	Removal
				Flash-point	Flow point			
MIL-L-2105	Lubricating oil, gear, multipurpose.	Grade 75w	A clean, homogeneous refined petroleum product with suitable additive agents.	302° F . . . 150° C	. . . .	For general use as lubrication of automotive gear units, heavy duty industrial type inclosed gear units, steering gears and fluid lubricated universal joints of automotive equipment.	Grease gun application.	Usually not required, but vapor degreasing or solvents will remove if necessary.
		Grade 80w-90	Same as above grease. . . .	329° F . . . 165° C	. . . .	For general use when prevailing atmospheric temperature is above 0° F (−18° C).	Grease gun application.	Not usually required, but petroleum solvents will remove if necessary.
		Grade 85w/140	Same as above grease. . . .	356° F . . . 180° C	. . . .	For general use when prevailing atmospheric temperature is above 20° F (−7° C).	Grease gun application.	Not usually required, but petroleum solvent may be used if necessary.
MIL-C-4339	Corrosion preventative, soluble oil; for water injection systems.	One grade only.	A soluble oil containing mineral oil; and suitable emulsifying and corrosion preventive agents.	. . . .	30° F . . . . −1° C Pour Point	To prevent corrosion caused by water alcohol mixtures, ground handling equipment and water injection systems.	Filling	Draining.

Table 2-3.—Continued

Specification No.	Specification title	Grade, type or class	Description	*Physical properties*		Uses	Application	Removal
				Flash-point	Flow point			
MIL-H-5606	Hydraulic fluid, petroleum base, aircraft, missile, and ordnance.	One grade only.	A pure petroleum product with approved additive to improve viscosity, temperature characteristics, and resistance to oxidation—with tricresyl phosphate added as an antiwear agent.	180° F... 82° C	−75° F (pour point). −60° C..	For use in automatic pilots, shock absorbers, brakes, flap control mechanisms, missile hydraulic servo-controlled systems, and other hydraulic systems using synthetic sealing materials.	Filling	Draining.
MIL-O-6081	Oil, lubricating, jet engine.	Grade 1005.	This is a refined petroleum which contains approved oxidation inhibitors and pour point depressants.	225° F... 107° C.	0° F..... −18° C	For use whenever jet engine oil is required. For the preservation of interiors of fuel cells and fuel system.	Filling	Petroleum solvent.
		Grade 1010.	Same as above	270° F... 132° C.	−70° F −57° C	Same as above	Same as above ...	Same as above.
MIL-L-6082	Lubricating oil, aircraft reciprocating engine (piston).	Grade 1065.	A refined petroleum product containing approved pour point depression.	420° F... 216° C.	0° F..... −18° C	For use in aircraft reciprocating engines.	Filling	Draining.
		Grade 1100.	Same as above oil	470° F... 243° C.	10° F.... −12° C	Same as above oil	Filling	Draining.
MIL-H-6083	Hydraulic fluid, petroleum base for preservation and operation.	One Grade Only.	A petroleum base oil with additive materials to provide corrosion protection and to improve the viscosity, temperature characteristics, and resistance to oxidation of the finished product. Must have no deleterious effect on pressure seal packings used in aircraft hydraulic systems and shock struts.	200° F... 93° C..	−75° F.. −59° C	As preservative oil in aircraft and ordnance hydraulic systems and as a testing and flushing oil for hydraulic components.	Filling	Draining.
MIL-L-7808	Lubricating oil, aircraft turbine engine synthetic base.	One grade only. .	A lubricating oil containing additives which impart oxidation stability, corrosion preventive properties and anti-wear properties.	400° F... 210° C.	0° F..... −18° C	For use in specific models of aircraft turbine engines, helicopter transmission, accessory and auxiliary equipment, auxiliary power units and other types of equipment requiring a synthetic base oil.	Any method at room temperatures.	Draining and flushing with petroleum solvent.

Table 2-3.—Continued

Specification No.	Specification title	Grade, type or class	Description	Physical properties		Uses	Application	Removal
				Flash-point	Flow point			
MIL-L-7870	Lubricating oil, general purpose, low temperature.	One grade only.	A clear transparent oil fraction, refined to provide lubricating quantities suitable for low temperature operations and containing additives which impart corrosion protective and oxidation-resistant properties.	265° F... 130° C.	-57° F.. -70° F..	For use wherever a general purpose, low temperature lubricating oil is required. It is especially designed for use where an oil of low evaporation, possessing is desired.	Any method at room temperatures.	Petroleum solvents or vapor degreasing.
MIL-C-8188	Corrosion preventive oil, gas turbine engine aircraft synthetic base.	One grade only.	A transparent, uniform corrosion preventive oil for use in engines normally operating on MIL-L-7808 oils.	400° F... 204° C.	-75° F.. -59° C	For preservation of turboprop and turbo-jet engines using MIL-L-7808 oils. The oil is capable of limited use, not to exceed 25 hours, as an aircraft lubricant and will be used for both preservation and final acceptance runs of engines of this type.	Filling	Draining and flushing with MIL-L-7808 oils.
MIL-H-17672	Hydraulic fluid, petroleum, inhibited	32 46 68	A mixture of petroleum-base hydraulic fluid plus anticorrosion and antioxidation additives.	315° F... *157° C.* 163° F... *325° F...* 171° C. 340° F...	-29° C *-20° F..* -23° C .... *-10° F..* -18° C - 0° F	For use in steam turbines, hydraulic systems, water turbine, water wheel type generators, and hydraulic turbine governors, where special non-mineral oil type hydraulic fluids are not required. Also in other applications where a general purpose lubricating oil having anticorrosion and antioxidation properties is required.	Filling	Draining.
		MIL-SYM 2135-T-H.	Same as above.	340° F... 171° C.	0° F..... -18° C	Same as above	Filling	Draining

Table 2-3.—Continued

Specification No.	Specification title	Grade, type or class	Description	Physical properties		Uses	Application	Removal
				Flash-point	Flow point			
MIL-H-19457	Hydraulic fluid, fire resistant non-neurotoxic.	....	An inhibited phosphate tester.	....	0° F ..... -18° C	For use as a test fluid and to protect hydraulic equipment which will ultimately receive phosphate ester type fire resistant hydraulic fluids from corrosion in transit, installation, or storage.	Fill and drain flush or spray.	Compatible with draining.
MIL-L-23699	Lubricating oil, aircraft turbine engines, synthetic base.	One grade only.	The composition of the lubricating oil is not limited, except that metal organic compounds of titanium are prohibited.	475° F ... 246° C .	-65° F .. -54° C	For use in specific models of aircraft gas turbine engines and helicopter transmissions, and other aircraft machine gear boxes within approximate temperature range of 40° (4° C) to 400° F (204 ° C).	Filling	Draining.
MIL-C-40084	Corrosion preventive compound, water-emulsifiable oil-type.	One grade only.	A fraction of mineral oil compounded with additives to give a fire-resistant, water-emulsifiable, oil-type corrosion preventive compound.	205° F ... 96° C ..	32° F .... 0° C ...	For use whenever a low cost, fire resistant, soft film, corrosion preventive can be utilized. Its fire resistant properties make it especially adaptable as a substitute for solvent cutback preservatives, where fire hazards increase the expense of application.	Applied hot by dipping. The compound is formulated to be emulsified in distilled or deionized water normally at a 1 to 4 ratio.	Petroleum solvents.
MIL-B-46176	Brake fluid silicone, automotive all weather, operational and preservative.	One grade only.	A silicone based hydraulic brake fluid.	100° F ...	....	For use in preserving hydraulic brake parts and components when packaged for warehouse storage. Also for use in preserving the hydraulic brake system of a vehicle when placed in standby storage, and as an operational fluid and preservative fluid in automotive hydraulic brake systems at ambient temperatures ranging from 131° F (55° C) to -67° F (-55° C) and fluid temperatures ranging from 401° F (205° C) to -67° F (-55° C).	Filling	Draining.

Table 2-3.—Continued

Specification No.	Specification title	Grade, type or class	Description	Physical properties		Uses	Application	Removal
				Flash-point	Flow point			
VV-B-680	Brake fluid, automotive.	One grade only.	A hydraulic fluid suitable for automotive hydraulic brake systems as indicated in the use column.	179.6° F 82° C		For use as an operating fluid in automotive hydraulic brake systems at ambient temperatures ranging from 131° (55° C) to minus 40° F (−40° C) and fluid temperatures ranging from 374° F (190° C) to minus 40° F (−40° C). It is not to be used in preserving brake parts and components in warehouse storage nor is it to be used in the brake system of vehicles that will be subjected to prolonged periods of standby storage.	Filling	Draining.

tics, unless they are combined in an assembly with corrodible metals. In this event, the preservative must be applied in such a manner to ensure the coating will not come into contact with the nonmetal portion or component of the item.

(2) *Surface finish.* If the item is forged, stamped, rough cast, rough ground, or rough machined, and has nonprecision uses, it may be protected by almost any of the petroleum type preservatives. On the other hand, items of precision use with surfaces held to close tolerances require an easily removed preservative, or one which may be left in place without interfering with the functioning of the item. Oil and light grease-type preservatives are preferred for these items. Small fragile items require light oil-type preservatives. Heavier preservatives are unsuitable because they may interfere with future operation or their removal may result in damage to the item.

(3) *Complexity of construction.* Items should be cleaned, dried, and preserved in as simple unit state as possible. Disassembled items with close tolerances should not be coated with heavy greases or hard-drying types of preservatives which may interfere with, or prevent later reassembly. If disassembly is not practical, or the item is highly irregular, with blind holes, crevices, and the like, heavy preservatives may be difficult to apply and impossible to remove. Molten grease types, carelessly applied, may result in some portions of complex items receiving no coating. This is true where air may be trapped in small, blind holes or crevices.

(4) *Extent of protection required.* The hazards to which the item may be subjected and the atmospheric conditions and time limits expected for the items must be considered. In most instances where time limits and severity of hazards are unknown, the best possible type of preservative should be used. If these time limits are short and the weather conditions to be encountered are mild, then work and expense may be saved by using light, temporary oil-type preservatives.

(5) *Ease or need for removal.* The user of the item must be kept in mind when choosing a preservative. The time required for removal, equipment available in the field, and whether removal is necessary, should all be considered before applying a preservative. Items shipped to a battle area which require time-consuming and elaborate removal equipment, might make a major difference in the outcome of a campaign. If complete or partial removal of the preservative is necessary in order for the item to function properly, a light, readily removable oil-type preservative should be employed.

(6) *Other functions of preservatives.* In some instances, the characteristics of the item or assembly requires that the preservative act also as a lubricating oil or hydraulic fluid. For example, engines require P-10 and hydraulic systems require P-15. In such cases, lubricating oil requirements for engines and hydraulic system requirements must be met first; the preservative properties are secondary. Dual purpose preservatives, therefore, should be used only where their dual function is required, and where it is known that the degree of preservation they offer will be sufficient. Generally, dual purpose types do not give the extent of protection given by those types which are primarily corrosion preventives. Whenever severe corrosion conditions will be encountered and the degree of protection offered by the dual material becomes insufficient, a material should be chosen definitely for its preservative qualities. The proper lubricant, hydraulic fluid, and the like, should be introduced at the place of use.

(7) *Packing to be used over preservative.* It is necessary to know if and how the items coated with the preservatives are to packed before a particular type of corrosion preventive is selected. Unless both the preservative and the method of preservation are considered, full protection cannot be expected. For example, if the preservative compound has no impact or abrasion resistance, then the packing and wrapping must be selected which will protect the preservative. If the characteristics and size of the item are such that physical limitations are encountered when designing the pack it may be necessary to select a preservative with good impact and abrasion resistance to prevent mechanical damage to the preservative coating. If the packed items may be exposed to rain, salt water, high temperatures, and other hazardous situations, it is necessary to correlate the type of preservative with the method preservation in order to offset the shortcomings of one or the other.

(8) *Availability of material.* If the proper and necessary preservative material is unavailable, then the best possible substitute should be used rather than omit using any preservative at all. However, when proper preservatives do exist, inconvenience or difficulty in obtaining them should not influence the choice. Damage through corrosion will far outweigh any special effort and expense necessary to obtain the most satisfactory material.

(9) *Difficulties of application.* Corrosion preventive materials definitely should not be chosen merely because they are easy to apply. This should be a governing factor only when all other previous requirements have been met. It is possible to find a suitable means of applying all approved materials.

2-12. Application by Dipping

This is done by the complete submersion of the item in a bath of the preservatives. This procedure is preferred whenever the size, shape, and nature of the item will permit its being used.

a. Loading Items for Dipping. Cleaned and dried items must be held on hooks, in baskets, by metal tongs, on wax-coated cord, or by gloved hands, in such a way that a complete coating and thorough drainage of excess material will result. Wire baskets, used for many small items in large quanity, should be loaded only one item deep, to permit the formation of a continuous, even coating around each item. Groups of fine, small items can be tied together with moisture free, wax-coated cord.

b. Dipping Items Into Preservatives. When items are dipped into the tank by hand or by conveyor, care must be taken that air bubbles are not caught on any of the surfaces of the item. Completely immerse items below the preservative level. Move them slowly beneath the surface to eliminate any air which may have been trapped inside. Keep them at the proper angle for coverage and draining. Trials should be conducted to determine the best temperature and length of time necessary for a suitable coating.

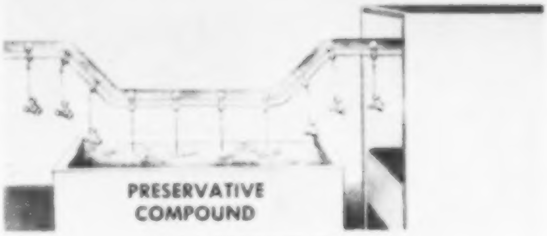
c. Removing Items From Tank. When removing items from the tank, allow excess compound to drain from all surfaces so that pools of material do not collect in corners and pockets. Items individually handled should be hung on hoods, rings, rods, or racks until preservative has set or dried. Items dipped in baskets are left in the baskets until the preservative film sets. Just before wrapping, any marks left by hook or hanger should be touched up by applying more preservative with a brush. Bare spots can be avoided somewhat by predipping hooks or baskets before dipping the items. After preservative has dried or set, the item should be placed on a precut piece of greaseproof barrier material. This should be the initial wrap for the packing operation. If items cannot be wrapped or packed immediately, they should be placed in baskets or trays and protected from dust and dirt with a suitable cover. Cleaned items left overnight should be carefully inspected for signs of corrosion before continuing with the application of preservatives (fig 2-4).

2-13. Application by Flow-Coating

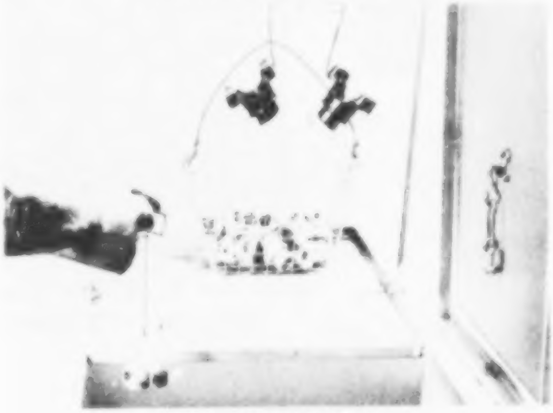
This procedure is accomplished by coating the surfaces of the item by pouring the preservatives on the item or portions of the item. This procedure is generally used for items too large to dip or on limited areas of items of complex nature which cannot be completely covered without injury to some of the materials of which they are made.

a. Positioning Items for Flow-Coating. Items are to be placed in such a manner, before coating, as to prevent pocketing of the preservative in blind holes or cavities. Tilt them to an angle that will permit free flow of the preservative and drainage by gravity.

b. Pouring Preservative on Items. Use oil type preservatives and pour slowly over surfaces to be coated. Flow on sufficient preservative to completely cover the desired areas and permit the excess of drain off by gravity. Avoid any unnecessary handling until after preservative has set. Do not handle items with bare hands or dirty gloves while applying the preservative (fig 2-5).



CONVEYORIZED DIPPING



HAND DIPPING

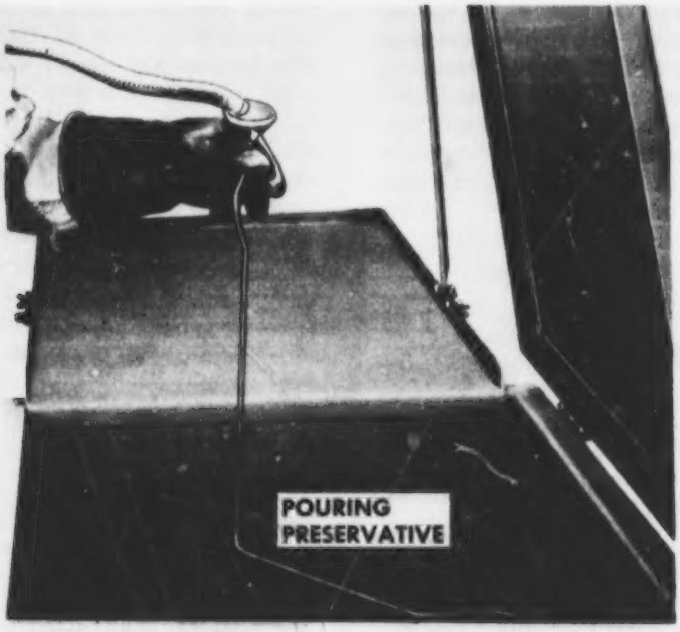
JMPTC 718 A

Figure 2-4. Application of preservatives by dipping.

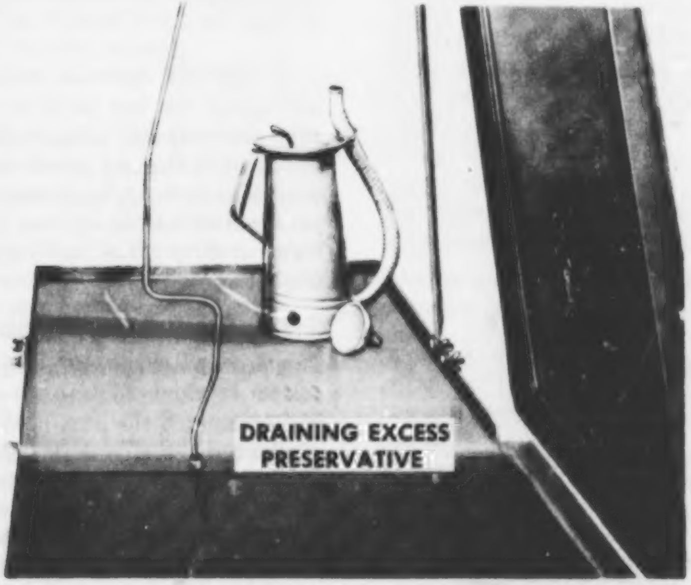
2-14. Application by Slushing

This procedure is performed by pouring the preservative into the item to be preserved and rotating, agitating, or slanting the item to insure complete coverage of all internal surfaces. The item is then drained of excess preservative. This procedure is most often used to coat inside surfaces of chambers, tubing, oil coolers, metal tanks, and other cavities not accessible by other procedures of application. For this reason, oils and soft thin film preservatives should be used. If properly selected, the preservatives do not normally require removal from the item before using. If removal should be required, they are easily flushed out.

a. Inserting the Preservative. Pour a sufficient quantity of the preservative into the interior of the


POURING
PRESERVATIVE

NOTE. POUR PRESERVATIVE INTO TUBE ALLOWING IT TO FLOW THROUGH TUBE AND COVER INTERIOR SURFACES.


DRAINING EXCESS
PRESERVATIVE

NOTE. DRAIN EXCESS PRESERVATIVE FROM TUBE BY HOLDING TUBE OVER PRESERVATIVE TANK ALLOWING PRESERVATIVE TO DRAIN INTO TANK.

JMPTC 719A

Figure 2-5. Application of preservatives by flow-coating.

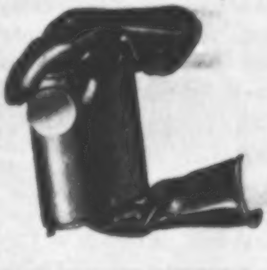
item to cover all surfaces when the item is rotated. If available, a small pump with a flexible outlet hose may be used to pump the preservative inside the item.

b. Slushing the Item. Shake, rotate, agitate, or slant the item in all directions to insure complete coverage of all interior surfaces. Never mix two different compounds for slushing, as this may cause a lumping of the ingredients.

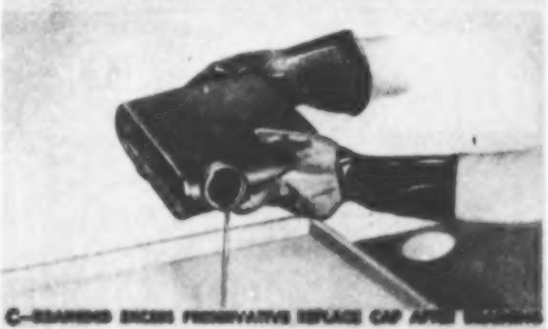
c. Draining off the Preservative. Drain off excess compound by rotating the item, if necessary, to prevent the collection of preservative in blind holes and crevices. It is always desirable that care be taken to prevent spilling the preservative thus avoiding safety or fire hazards. Equipment and methods of operation should insure economy through the re-use of slushing oils.

d. Closing the Item. After draining, close all openings of the item to keep out dirt and other foreign matter. Plastic plugs are most satisfactory for sealing openings. Male and female types are available for various kinds of openings. Never use wooden plugs as closures, since splinters from the wood are difficult to remove and may clog fuel or oil lines and cause serious damage (fig 2-6).

A—INSERTING PRESERVATIVE



B—ROTATING OR SLUSHING ITEM



C—DRAINING EXCESS PRESERVATIVE REPLACE CAP AFTER DRAINING

JMPTC 717

Figure 2-6. Application of preservatives by slushing.

2-15. Application by Brushing

Brushing is performed by coating the item or limited surfaces of the item with a preservative, by means of a brush. This procedure is used when no other procedure is available or suitable. Brushing is used extensively where only one part of an assembly require the coating, such as against hinge fittings, inside surfaces of bushings, or bare metal surfaces next to fabric or rubber materials that must not be coated with preservative compounds.

a. Applying the Coating. Make sure the item is clean and dry before brushing. Use only clean brushes for applying the coating. Apply an even and continuous coating. Do not handle items with bare hands or dirty gloves.

b. Checking the Coating. Inspect item to be sure that areas not readily visible are not left uncoated. It may be necessary for more than one brush application to provide an unbroken, continuous coating (fig 2-7).

2-16. Application by Filling or Flushing

This procedure is accomplished by completely filling the items with preservative until all interior surfaces are satisfactorily coated.

a. Filling Item. Insure coverage of all interior surfaces by completely filling the item with preservative. Care should be taken so that entrapped air will not prevent complete coverage of the interior surface. Oils or easily removed thin film preservatives are to be used for filling.

b. Draining Preservative. Drain off the preservative oil and close up the openings. If oil is not to be drained, space must be allowed for thermal expansion. Close all openings and make sure they are sealed to prevent any leakage. Wipe up any spilled oil to avoid possible fire hazards (fig 2-8).

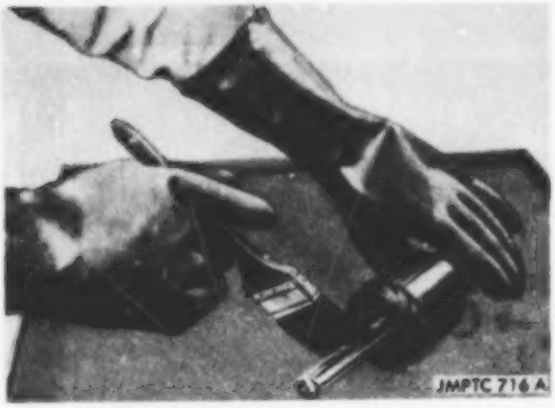


Figure 2-7. Application of preservative by brushing.

2-17. Application by Fogging

This procedure is accomplished by coating interior surfaces of items, such as tanks and chambers, with preservatives injected as a cloud or mist from an air atomizing gun until the inclosed atmosphere is saturated.

a. Preparing Fogging Gun. Fill the gun container with a light preservative oil and attach the flow of preservative fluid by turning the base of the handle grip. Press thumb valve or finger trigger, allowing fluid to run. Adjust the flow of preservative fluid by turning the nozzle to the left to increase and to the right to decrease the flow of preservative. Tighten the locknut on the nozzle after the flow has been adjusted, and keep the air vent located on the left side of the container open. Be sure air is dry.

b. Fogging Interior of the Item. Insert the nozzle through the opening of the item and fog until atomized mist begins to come out around the nozzle. If more than one opening is available on the item, repeat the process at these openings to insure complete fogging of the interior. For extra large tanks or chambers, extensions are available to attach to the nozzle to reach into otherwise inaccessible corners and pockets (fig 2-9).

2-18. Application by Spraying

This application is done by coating surfaces (interior or exterior, as applicable) of the items with preservative applied as a spray. Spraying is especially useful for preservation of large and heavy items that cannot be dipped, or assemblies requiring a preservative only on certain portions of their surfaces. Thin film or oil-type preservatives usually are used in spraying.

a. Preparing Item for Spraying. Mask all surfaces that are not to be coated, including such parts as fiber looms, electrical wiring, receptacles, rubber and fabric components. Suitable materials for masking are kraft paper and pressure-sensitive tape. P-1 type preservatives and oils will not damage paints or primers on metal surfaces and such surfaces are not usually masked.

b. Spraying the Item. Spraying must be done in a well ventilated area. Wear protective clothing, masks, gloves, etc. Fill spray gun with the selected oil or thin film preservative. If P-1 preservative is to be used, it may be necessary to dilute it with petroleum solvent until it will spray effectively. Adjust spray gun and apply an even, continuous, and unbroken film around

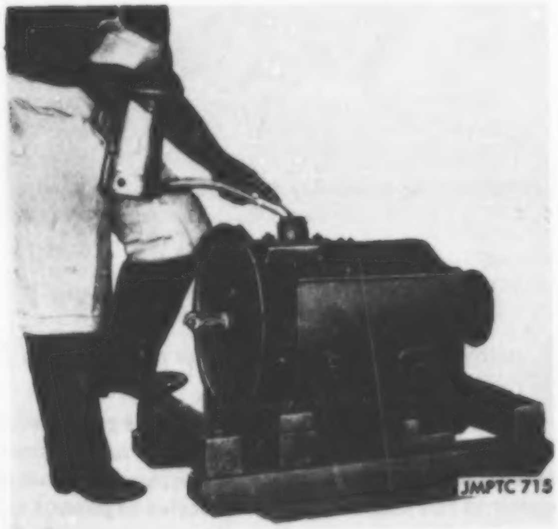


Figure 2-8. Application of preservatives by filling or flushing.

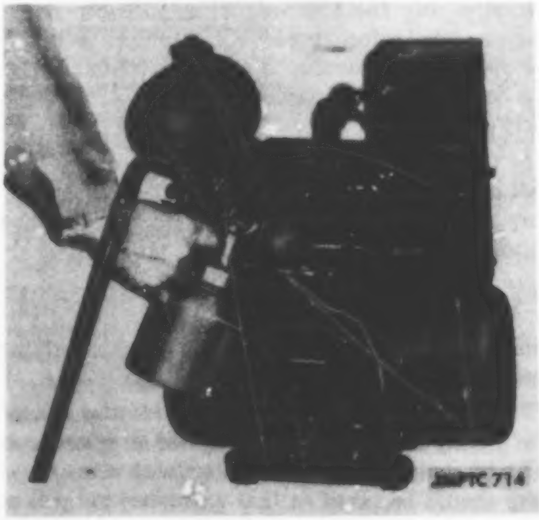


Figure 2-9. Application of preservatives by fogging.

each item surface. Use normal spray painting technique for applying the coating. Allow preservative coating to thoroughly dry or set before further handling (fig 2-10).

2-19. Preservation Using Volatile Corrosion Inhibitors (VCI)

a. Concept of Volatile Corrosion Inhibitors.

(1) *Development of VCI.* Chemists have known for some time that certain chemicals give off vapors, such as camphor and moth balls. Some of these chemicals are known to inhibit corrosion and neutralize the effects of moisture laden air within a package. These chemicals are called Volatile Corrosion Inhibitors or VCI. They are available for packaging applications in several forms (*c* below).

(2) *Description of VCI.* VCI compounds are white crystalline powders similar in appearance to a fine talc. While the crystals are used in some instances, for preserving interiors of engines and other applications, the most widely used forms of the material are coated and impregnated papers. As a coating, the chemical is mixed with casein which acts as a bond or adhesive to stick the crystals to the paper surface. In impregnated papers, the process consists of soaking the paper in a solution containing a concentration of the inhibitor. The solution evaporates and leaves the crystals impregnated in the fibers and the surface of the paper.

(3) *Action of VCI.* When used as a wrap around an item, the crystals in the paper slowly vaporize. This vapor moves from the paper and fills the entire volume within the pack. When the vapor concentration reaches a certain level, an equilibrium is established, provided the pack is airtight, so that crystals will condense on the surface of the item as rapidly as they vaporize from the paper. The vapor forms, on all surfaces of the item, including all cracks and crevices, and invisible, adhering, protective film which resists the corrosive action of water vapor. Corrosion is prevented as long as the chemical remains active and this will depend on the effectiveness of the pack in keeping the vapors concentrated inside (fig 2-11).

b. When To Apply VCI.

(1) *Advantages of using VCI.* VCI offers effective protection to iron and steel. This protection is equal to, or better than that provided by the more commonly used P-type preservative compounds. VCI provides good protection to areas of an item where it would be impossible or impractical to apply a grease or oil type preservative. Such areas as small holes, blind holes, cups, cavities, or threads, are also protected by the vapors of VCI. VCI offers a choice in the degree of protection given to military supplies and equipment. This may vary from temporary protection given to items during processing operations, through protection for shipment and immediate use, to complete protection

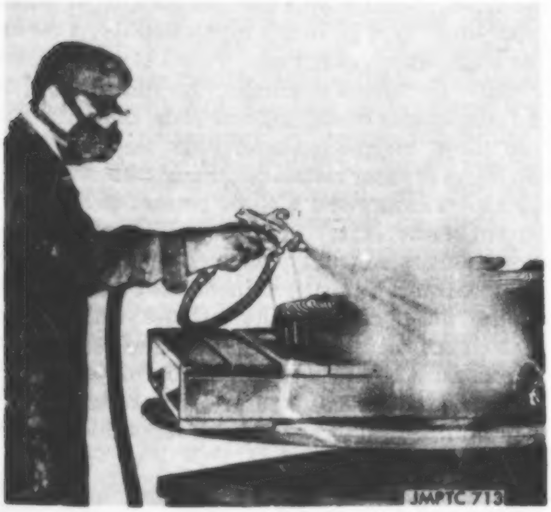
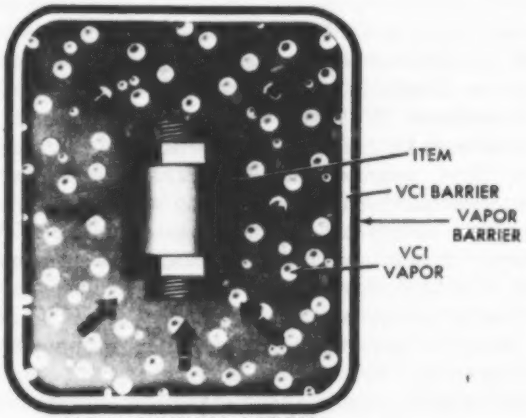
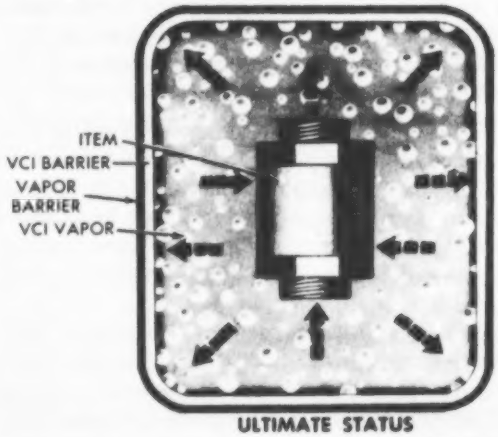


Figure 2-10. Application of preservatives by spraying.



INITIAL PHYSICAL ACTION



ULTIMATE STATUS

JMPTC 712

Figure 2-11. Action of VCI.

for long-term storage or oversea shipment. VCI provides for savings through the simplicity and ease of its application. It reduces labor and time in the complicated preserving and depreserving operations normally associated with the use of grease and oil type preservatives. VCI offers a strategic advantage by allowing many essential stored items to be ready for immediate use. Weapons need little or no disassembly or cleaning and reassembly prior to use. Production equipment and machine tools may be stored in convenient areas where little time would be required to put them put into production.

(2) *Restrictions and limitations in the use of VCI.* VCI materials will not protect all metals from corrosion; in fact, they appear to increase the rate of corrosion in certain metals. VCI materials must not be used to protect any assemblies containing optical systems or precision moving parts which have been coated with a preservative or lubricant, unless otherwise specified. Items protected with bonded films, such as molybdenum (a dry lubricant), are not included in this category. VCI materials are affected by heat and light. They lose their effectiveness as the temperature increases and they decompose if exposed to direct sunlight for extended periods. They also decompose in the presence of acids or strong alkalies. Precautions must be taken when VCI is used with items, assemblies, and subassemblies containing zinc plate, cadmium, zinc-base alloys, magnesium-base alloys, lead-base alloys, and alloys of other metals including solders and brazing alloys. If such items contain more than 30 percent of zinc or 9 percent of lead, they must not be preserved with VCI. In all cases, direct contact of VCI with nonferrous metals except aluminum and aluminum-base alloys should be avoided unless specific permission has been granted. Care should also be taken with assemblies containing plastics, painted parts, or components of natural or synthetic rubber. Assemblies containing parts made of these materials should not be packed with VCI until proof is established that they have passed the compatibility test required by Specification MIL-I-8574.

c. *Forms of VCI.* VCI materials are supplied in the form of coated and impregnated wrapping papers, barrier materials, fiberboard laminates, flexible transparent films, crystalline solids, fabricated bags, treated lubricating oils, and other forms. Those forms for which specifications have been developed are described below;

(1) *Packaging materials, volatile corrosion inhibitor, treated, opaque (MIL-P-3420).* This specification establishes the requirements for treated materials (kraft paper, barriers, or fiberboard laminates) which may be coated or impregnated with the corrosion inhibitor. These treated materials are furnished in two types based on extent of application, three classes based on strength of the material, and seven styles based on the composition of the material. Type I material is for general application and Type II is for limited application. Type I material must be compatible with flexible barrier material (MIL-B-131) and both types, I and II, must be compatible with copper. Style A is made from flat kraft paper: Style B is made from creped or embossed kraft paper; Style C, greaseproof, waterproof, moldable material, is made by laminating heavy or medium duty VCI treated Kraft to aluminum foil (QQ-A-1876), Style D, greaseproof, waterproof, moldable, self-adhering material, is made by laminating heavy or medium duty VCI treated Kraft to a grease-proof barrier material, Grade C of MIL-B-121; Style E is made of laminated fiberboard as specified by the procuring activity; Style F is made of single or multiple asphalt laminates made of heavy, medium, or light duty VCI treated kraft paper; Style G, greaseproof material made of heavy, medium, or light duty VCI treated kraft shall be constructed to conform to Grade A of MIL-B-121. 1. These materials are used in accordance with Specification MIL-I-8574 (*e* below).

(2) *VCI-treated, heat sealable, flexible, transparent film (MIL-F-22019).* This specification covers a transparent, flexible, heat sealable film coated or impregnated with VCI. It is intended for use in packs where transparency is desired to facilitate inspection of the item without disturbing the pack. Packs fabricated from this VCI-treated film are designed mainly for short-term protection (not to exceed 24 months). The material is also intended for shipboard use. It must be applied in accordance with Specification MIL-I-8574 (*e* below, and table 3-4).

(3) *Crystalline VCI (MIL-I-22110).* This specification covers the requirements for solid forms of volatile corrosion inhibitors. The material is furnished in two types. Type I, with a low volatility, is for general application. Type II, with a high volatility, is for limited application. Specifically, Type I is used as a preservative for ferrous aluminum, aluminum-base alloys, and components containing zinc plate, cadmium, zinc-base alloys, magnesium-base alloys, lead-base alloys, and alloys of other metals (including solders and brazing alloys) having less than 30 percent of zinc and 9 percent of lead. Direct contact with nonferrous metals, except aluminum and aluminum-base alloys, must be avoided. Direct contact with nonmetals should also be avoided, unless compatibility with the particular nonmetal(s) has been established. Packages using Type I crystals must be sealed to prevent loss of vapors. Type II crystals have the same uses as Type I, except that they must be used in sealed water-vaporproof containers.

(4) *Contact and volatile corrosion inhibited lubricating oil (MIL-L-46002).* This specification covers a volatile corrosion inhibited oil for use in enclosed sys-

tems where the VCI will provide protection above the oil level. It can also be effectively used as a contact preservative. It is not intended to be used in applications where magnesium, cadmium-plated or rubber components are present. The inhibited oil is furnished in two grades. Grade 1 is a light viscosity oil and grade 2 is a medium viscosity oil. A minimum of 0.15 quart of grade 1 or 0.25 quart of Grade 2 should be used for each cubic foot of volume to be protected. In addition to the above VCI oil, there is another oil type volatile corrosion inhibitor conforming to MIL-I-23310, designed specifically for Navy use.

(5) *Barrier bags with VCI-treated liners (MIL-B-40028).* This specification covers the requirements for heat sealable, water-vaporproof barrier bags, lined with VCI-treated paper. These bags are furnished for general purpose use (Type I), and special purpose use (Type II). They are made of heavy duty (Class A) and medium duty (Class B) materials (table 3-3). The bags are intended primarily for use in packing items that are adaptable to protection by VCI-treated materials for indeterminate storage and overseas shipments, where high resistance to corrosion of ferrous metals is required. Items containing nonferrous metals or nonmetals may be packed in these bags within the limitations for Type I, VCI-treated materials, covered by Specification MIL-P-3420, as described in Specification MIL-I-8574. Class A, Type I—heavy duty, general purpose bags-are fabricated from class 1, MIL-B-131 barrier material, with a VCI-treated liner made from Type I, grade C material of Specification MIL-P-3420. Class B bags are fabricated from class 2, MIL-B-131 barrier material, with a VCI-treated liner. Type I bags are made in accordance with the requirements for class E, MIL-B-117 bags. Type II bags are fabricated in accordance with drawings or contract requirements of the procuring activity.

(6) *VCI-treated, flexible, heat sealable transparent bags (MIL-B-22020).* This specification covers the requirements for flexible, heat sealable, transparent bags treated with VCI. The bags are fabricated from heat sealable, transparent, VCI-treated film conforming to Specification MIL-F-22019. They are available in eight different sizes as shown in table 3-3. They may also be procured in dimensions as specified by the contract or purchase order. These bags are used in accordance with Specification MIL-I-8574 (e below) and are intended primarily for use in packaging of items that are adaptable to protection by VCI-treated materials for short-term storage, domestic and overseas shipment, and shipboard use. Short-term storage is here defined as not exceeding 24 months.

(7) *Other forms of VCI.* Although specifications have not yet been issued covering them, there are other forms of VCI available to industry which may be used if permitted by the military activity concerned. Volatile corrosion inhibitors are now available in tablet form. The tablets can be used in automatic packaging of small items such as bolts, pins, dowels, screws, drills, taps and dies, etc., where a hopper feed machine can form a bag, drop in the item and a pellet in the bag, and seal the bag in a single operation. Also available are VCI crystals compounded with a noncaking agent and supplied in 2-ounce cotton bags; VCI-treated papers fabricated into bore tubes for small arms preservation; envelopes of VCI-treated kraft; spirally-wound fiber cans (MIL-C-3955) and fiberboard boxes (PPP-B-636) coated with VCI; and aerosol containers with VCI dissolved in alcohol.

d. Handling of VCI Materials.

(1) *Sheets and rolls.* VCI materials must be stored in cool, dry location. Original packages must not be opened until shortly (not more than 24 hours) before use. During use operations, the material must be protected from excessive heat, direct sunlight, moisture, strong drafts, and excessive dust. At the close of each working day, VCI-treated materials should be replaced in their original containers or completely wrapped or covered with aluminum foil (QQ-A-1876), greaseproof barrier material (MIL-B-121, Grade C), or water-vaporproof barrier material (MIL-B-131). Should any material be subjected to damaging or adverse conditions, its effectiveness can be determined by the vapor inhibiting ability (VIA) test found in the appropriate material specification.

(2) *Lined barrier bags.* Barrier bags lined with VCI-treated materials are self-protecting, except for the unsealed ends which can be folded over to retain the vapors. Punctured or otherwise damaged bags should be discarded. When feasible, the lines should be stored separately from the bags until ready for use.

(3) *Bore tubes.* VCI-treated bore tubes must be kept in a closed, barrier-type container. The container should be opened only for withdrawal of tubes for immediate use.

(4) *Handling precautions.* VCI materials may include ingredients irritating to the eyes and skin of some people. Do not rub or wipe eyes while handling VCI-treated materials. After handling, wash hands thoroughly with soap and water.

e. How To Apply VCI Materials (MIL-I-8574).

(1) *Cleaning and drying.* Metal items to be protected with VCI must be cleaned and dried in accordance with any of the processes and procedures of Specification MIL-P-116 (sec I). If a vapor degreaser is used, operation and control instructions furnished by the manufacturer of the degreaser must be strictly followed to prevent the possibility of acid residues being left on the item which would render the VCI ineffective and promote corrosion.

(2) *Use of VCI with operational lubricants.* When

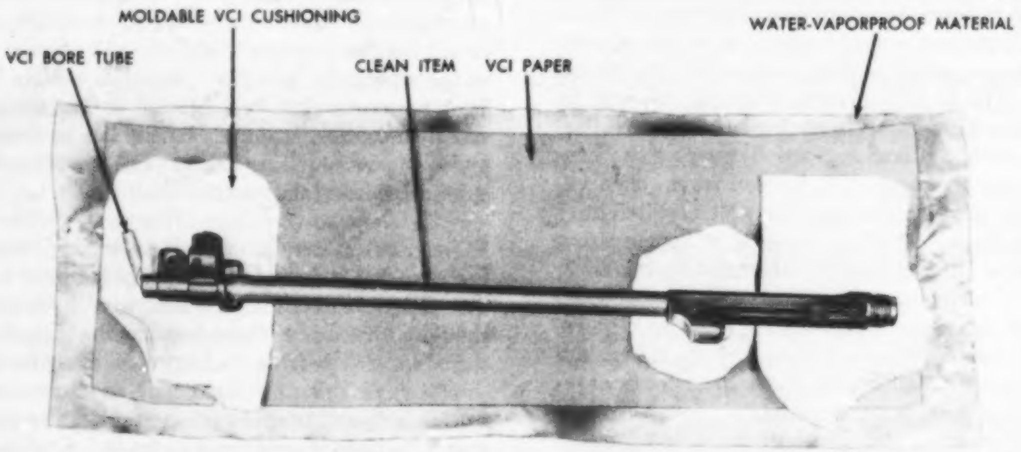
VCI materials are used on assemblies containing operational lubricants, it is necessary to establish the fact that the specific VCI and the lubricants being used are compatible. Prior to the application of the VCI to the assemblies, the excess oil must be drained off. This is not required in the case of items protected with bonded films.

(3) *Application of sheets and rolls (MIL-P-3420), treated films (MIL-F-22019), and transparent bags (MIL-B-22020).* Unless otherwise specified, VCI-treated materials must completely inclose the item, or the item may be wrapped with strips of the material without any other material between the item and the wrapping. Complete wrapping, where feasible, is preferred. The treated face of the material must be placed toward the item being wrapped. The wraps should be applied in such a manner that any air entering the pack will pass through or over the surface of the VCI before reaching the item. The VCI-treated materials should not be more than 12 inches away from any surfaces to be protected (fig 2-12). Whenever possible, the opening of the VCI-treated, transparent bags (MIL-B-22020) should be heat sealed.

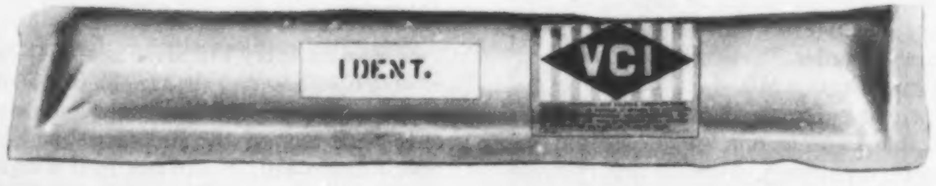
(4) *Crystalline VCI (MIL-I-22110).* These materials are sprayed, atomized, or dusted over the entire surface of the item. If feasible, the VCI should also be sprayed, dusted, or atomized into the inclosing container immediately before sealing.

(5) *Material in tiers or layers.* When items are packed in tiers or layers, the VCI should be placed between the tiers. Where VCI-treated materials are used in a box containing separators, all faces of the separators must be lined with VCI-treated material, in addition to lining the inside of the box.

(6) *Amount of VCI required.* When used as a complete overwrap, the amount of VCI-treated barriers (MIL-P-3420) and films (MIL-F-22019) should at least equal ⅓ of the surface area of the inclosing container. When not used as an overwrap, the amount of VCI-treated material must be at least equal to the sur-



PRESERVATIVE, CUSHIONING AND VCI WRAPPING AS REQUIRED



WATER-VAPORPROOF BAG, SEALED

Figure 2-12. Application of packaging with VCI-treated materials.

face area of the inclosing container. VCI crystalline (MIL-I-22110) should equal 1 gram per cubic foot of volume of the inclosing container.

(7) *Packaging components with closed spaces and blind end cavities.* Assemblies with enclosed portions, such as gear boxes, must be protected with strips of VCI material placed inside and the opening sealed. Open end voids, where the opening is small in relation to the void, should be treated likewise. Open end voids of a depth greater than 6 inches, such as gun barrels or bolt holes in castings, should have an inserted strip or tube of VCI-treated material slightly longer than the depth involved. The protruding portion of the bore tube or strip should be bent over and held in place with tape or other material to aid in its removal. Whenever an enclosed area of an assembly is preserved with VCI and sealed, a label or a tag must be attached to assure that the assembly is not used prior to the application of the proper lubricant.

(8) *Use of cushioning and dunnage.* Projections or sharp corners and edges of the item shall be cushioned with moldable VCI-treated materials to prevent damage either to the item or the barrier. Where dunnage is required next to, or around the item, a facing of VCI-treated material must be placed between the item and the dunnage. When the dunnage or other nonmetallic materials used in the package are hygroscopic or may give off corrosive vapors, the item and the VCI must be isolated by the use of aluminum foil or other suitable barrier material (para 3-5).

(9) *Use of greaseproof barriers.* When VCI-treated items, coated with operational oils, are packed with outer packing materials that are not greaseproof, a greaseproof barrier must be used to separate the packed items from the outer materials. Styles C and D of MIL-P-3420 VCI-treated barrier materials may be used for this purpose since both styles incorporate a greaseproof barrier in their composition.

(10) *Marking of VCI packs.* Unit and intermediate packs shall be marked for identification in accordance with Military Standard MIL-STD-129. When specified, each container shall be labeled in accordance with Military Standard MS-16110.

CHAPTER 3

METHODS OF PRESERVATION (UNIT PROTECTION)

3-1. General Principles and Requirements

Preservation is the application or use of adequate protective measures to prevent deterioration resulting from exposure to atmospheric conditions during shipment and storage. Such protective measures, when applied to military supplies and equipment, include, as applicable, the use of appropriate cleaning, drying, preservative, and packing materials. Methods of preservation (unit protection) are therefore those sets of protective measures which have been developed, grouped together, tested, and are presently approved for the prevention of deterioration of military supplies and equipment. The methods of preservation are established by Military Specification MIL-P-116, and consist of six basic methods. These basic methods are: Method I, preservative coating (with greaseproof wrap as required); Method IA, watervaporproof enclosure (with preservative as required); Method IB, strippable compound coating (hot or cold dip); Method IC, waterproof barrier (with preservative as required); Method II, water-vaporproof barrier with desiccant with contact preservative when required); and Method III, packaged for mechanical and physical protection only (fig 3-1). Detailed procedures for accomplishing the methods of preservation are found in paragraphs 3-7 through 3-33. Methods I, IA, IB, IC, II, and III have not been designed to be exclusive or independent of each other; they are setup as six basic methods. Combinations of these methods within the restrictions of MIL-P-116 and this manual may be desirable for application to specific problems. Preservation operations, once begun, should progress in an uninterrupted series of operations. When periods of interruption are necessary, temporary protection should be provided to partially processed items to insure against contamination. When the exact method of preservation has not been specified, the method to be used shall be based on the composition of the item, the nature of its surface, its construction, and the level of protection desired. General requirements for the application of the methods of preservation, regardless of the individual method or submethod used, are as follows:

a. Packs shall be designed to conserve weight and space.

b. Materials used shall be those approved by the Government and specified in pertinent documents.

c. If the selected method or submethod requires the use of a barrier material or container, preliminary wrapping, cushioning, or dunnage materials shall be applied, as necessary, to items having projections and sharp edges to prevent damage to the barrier material or the container, and to control or prevent movement of the item within the barrier or container.

d. Cushioning and dunnage materials used within waterproof or water-vaporproof barriers shall be as dry as practicable to minimize contaminants.

e. Preliminary wrapping, cushioning, and dunnage materials in contact with preservative coated surfaces shall conform to the requirements established for the following: aluminum foil, QQ-A-1876; Grade A, greaseproof, waterproof, flexible barrier material, MIL-B-121; or Type I and II, film, transparent, flexible, heat sealable, MIL-B-22191. Preliminary wrappings applied merely to confine a contact preservative onto a surface are not necessary when bags made of materials conforming to Grade A, MIL-B-121; MIL-B-131; or Type I or Type II of MIL-B-22191 (table 3-4) are used as unit containers.

f. Wrapping, cushioning, and dunnage materials in contact with bare (uncoated, unplated, or untreated) metal surfaces shall be capable of meeting the requirements of Test Method 3005 of Federal Test Method Standard 101. Neutral papers conforming to MIL-P-130, MIL-P-17667 and Type II of UU-P-553 meet the compatibility requirements of this specification and are available at a lower cost. Materials shall be as dry as practicable at time of use.

g. Items or packs protected in accordance with the methods of preservation shall pass the required tests established in MIL-P-116 for each method and submethod (table 3-11).

h. For storage and handling purposes, methods of preservation may be supplemented by cartons, boxes, or other suitable containers, at the discretion of the procuring agency.

i. When specific materials, such as barriers, wraps, cushioning, dunnage, or containers are required, they shall be specified in the contract or order.

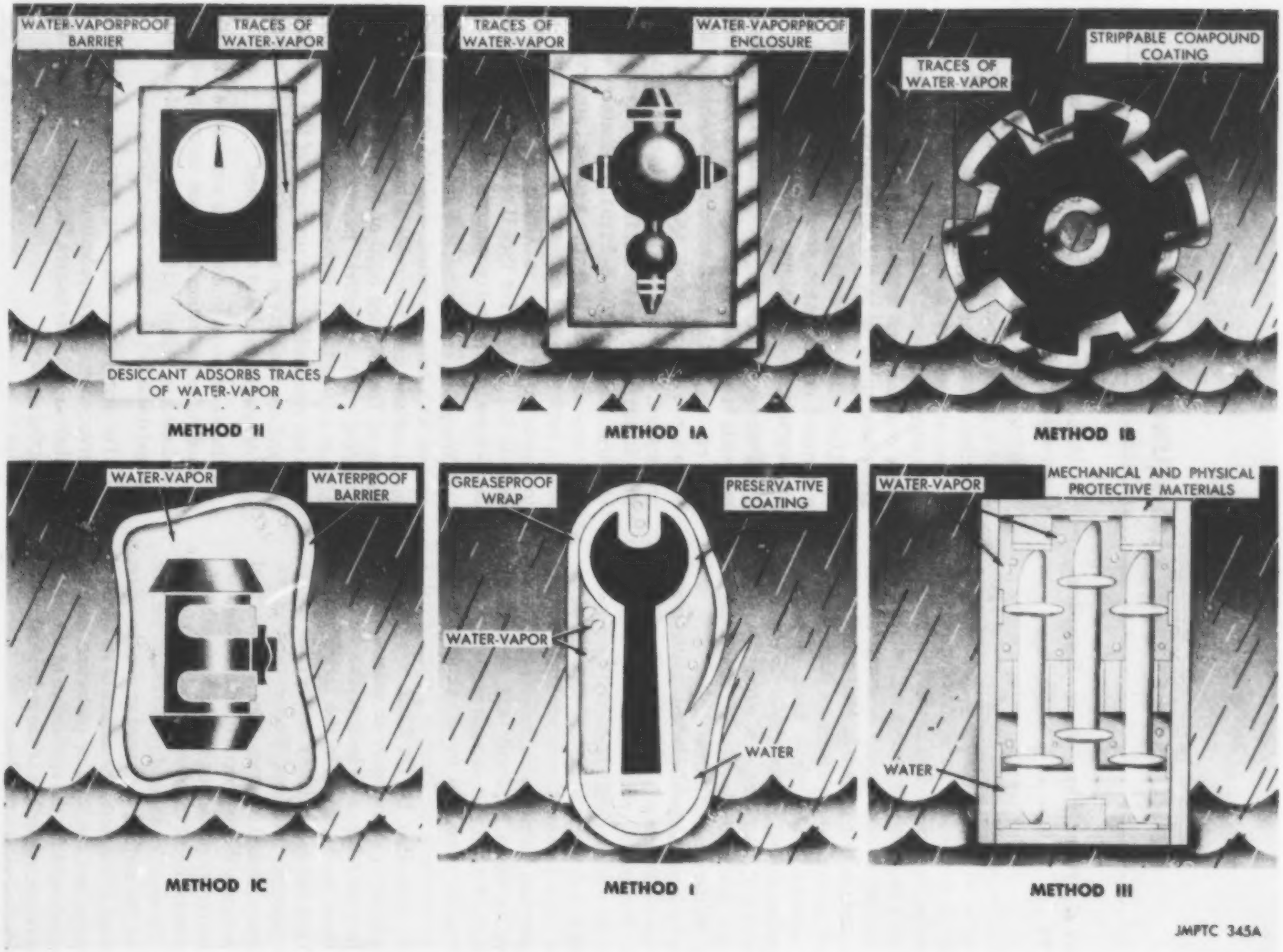

WATER-VAPORPROOF BARRIER
TRACES OF WATER-VAPOR
DESICCANT ADSORBS TRACES OF WATER-VAPOR
METHOD II
TRACES OF WATER-VAPOR
WATER-VAPORPROOF ENCLOSURE
METHOD IA
TRACES OF WATER-VAPOR
STRIPPABLE COMPOUND COATING
METHOD IB
WATER-VAPOR
WATERPROOF BARRIER
METHOD IC
GREASEPROOF WRAP
PRESERVATIVE COATING
WATER-VAPOR
WATER
METHOD I
WATER-VAPOR
MECHANICAL AND PHYSICAL PROTECTIVE MATERIALS
WATER
METHOD III
JMPTC 345A

Figure 3-1. Concepts of the basic methods of preservation.

j. MIL-P-116 requires that small bags be fabricated in accordance with MIL-B-117, Bags, Sleeves, and Tubing. Information regarding these requirements is found in paragraph 3-4(c). Large watervaporproof bags must be fabricated in accordance with MIL-E-6060, Envelopes, Packaging, Watervaporproof, Flexible, when the size limitations of MIL-B-117 are exceeded.

k. Field force protection (shielding). Sensitive electronic devices and other items susceptible to environmental field force damage shall be protected, as specified, by one or more of the procedures specified below to prevent item damage from electrostatic, electromagnetic, magnetic or radioactive forces during handling, shipment and storage from time of manufacture until use.

(1) *Electrostatic protection.* Electrostatic protection shall be accomplished by enclosing the sensitive items in bags (envelopes) or pouches conforming to MIL-B-117, Type I, Class F, Style 1 or Type I, Class A, Style 2 or MIL-P-81997 or barriers conforming to MIL-B-81705. Sensitive electronic items (devices) requiring both electrostatic and electromagnetic protection shall be enclosed in bags conforming to MIL-B-117, Type I, Class F, Style 1 or barrier conforming to MIL-B-81705, Type I.

(2) *Electromagnetic protection.* Electromagnetic protection shall be provided by enclosing the items in bags or envelopes conforming to MIL-B-117, Type I, Class F, Style 1. Sensitive electronic items (devices) requiring both electrostatic and electromagnetic protection shall be protected as specified in (1).

(3) *Magnetic protection.* Protection from simple magnetic fields (as opposed to RF or electromagnetic radiation) shall be accomplished by completely enclosing the sensitive items in ferrous metals or ferritic compositions of sufficient thickness to provide the degree of protection required.

(4) *Radioactivity protection.* Protection from radioactivity shall be accomplished by completely enclosing the items in lead filled compositions.

3-2. Sources of Packaging Requirements

With definite advances in the standardization of packaging and packing requirements for items of supply common to the three military departments, the problem of determining the packaging requirements for individual items is becoming less and less the responsibility of packaging personnel at the local level. As a general rule, service installations and activities having national industrial engineering or procurement missions, establish the packaging requirements for their assigned material. Promulgation of these requirements is then made through one or more of the following media:

a. Section 5 of Specifications. Section 5 (Packaging) of Federal and Military commodity specifications establishes the requirements for the packaging, packing, and marking of the materials, products or equipment covered by these specifications. Thus, to determine the requirements for the packaging of flexible vinyl chloride plastic film, section 5 of Specification L-P-375 will be consulted; to determine the requirements for the packaging of color change, plug-type humidity indicators used in Method II packages, Section 5 of Specification MIL-I-26860 shall be consulted.

b. General and Detail Packaging Specifications. In this case, specifications are written dealing with the packaging requirements for individual items or groups of related items. Examples of specifications covering individual items are: MIL-C-45008, Carbine Cal. .30 M1, M2 and M3, Packaging of; MIL-T-45309, Tank, Combat, Full-Tracked, 105-mm Gun, M60 and M60A1, Processing for Storage and Shipment of. Examples of specifications covering groups of items are: MIL-R-196, Repair Parts for Internal Combustion Engines, Packaging of; MIL-P-17207, Preservation and Packaging of Horological Repair Parts and Accessories, Associated with Navigational Timepieces; and PPP-P-40, Packaging and Packing of Handtools.

c. Packaging Control Forms. Packaging control forms are used to specify detailed packaging information for individual items or groups of items. This information includes the procedures and methods to be employed, the kinds, sizes and quantities of materials to be used, etc., which are not usually found in general or detail packaging specifications. The format of packaging control forms at the present time varies with the different departments. Examples of packaging control forms are Packaging Data Sheets, Packaging Engineering Specification Cards, Packaging and Packing Control Records, Request for Preservation Cards, and Packaging Standards and Special Packaging Instructions.

3-3. Codification of Packaging Requirements

Prior to the publication of Military Standard MIL-STD-726 (Packaging Requirements Code), locally developed codes were utilized in an attempt to abbreviate and simplify the recording of lengthy identification and descriptive data in regard to packaging requirements. With the publi-

Digit Position	Code Fields	See Table	EXAMPLE:	
1 2	Method of Preservation	II, IIa IIb IIc	3Q	Method IA-14
3	Quantity per unit package	III	1	One per unit package
4	Cleaning and drying procedure	IV	1	Cleaning process C-1
5 6	Preservative Material	V	06	Preservative P-6 of MIL-P-116
7 8	Wraps	VI	GB	MIL-B-121 Greaseproof-waterproof barrier, Grade A
9 10	Cushioning and Dunnage	VIa	BA	PPP-C-843, cellulosic cushioning material
11	Cushioning Thickness	VIb	B	1/2-inch thick
12 13	Unit Container	VII	FD	PPP-B-636, Type CF, Class weather resistant, fiberboard box
14	Intermediate Container Quantity	VIII	6	6 pkgs. per intermediate cont.
15 16	Intermediate Container	VII	WE	Kraft paper overwrap
17	Level of Protection	IX	A	Level A

Table 3-1

JMPTC 916 Ia

cation of the Standard in May of 1960, a uniform and mandatory system was developed for coding essential preservation and packing information in a convenient form, capable of being stored and managed by existing electronic data processing methods and equipment, or by manual means. The codes, definitions and use requirements established in MIL-STD-726, are mandatory for use by all agencies within the Department of Defense which use coded packaging data in procurement operations. The code system established by the standard is both a position and sequence code (table 3-1). Coded data used under the system will always appear in the sequence and in the number of positions specified in the standard, regardless of the method of publication. For purposes of uniformity, the standard establishes the following as the minimum essential elements which will be used for procurement purposes:

a. Method of preservation.
b. Quantity per unit pack.
c. Cleaning and drying procedure.
d. Preservative material.
e. Wraps, cushioning, and dunnage.
f. Unit container.
g. Intermediate container quantity.
h. Intermediate container.
i. Level of protection.

In addition to the basic packaging information set forth above, codes are provided for alternately including one or the other of the following items of logistical information:

Allowable maximum weight and cubage of the unit container, or—

Allowable maximum inside dimensions (length, width, and depth) of the unit container. Codes for the selected code fields are provided in various tables contained in the standard. The Standard also include codes for exterior containers.

3–4. Packaging Materials

a. General. Among the most commonly used packaging materials are adhesives, bags, sacks, and envelopes, barrier and wrapping materials (opaque and transparent), cushioning materials, desiccant, humidity indicators, inspection windows, labels, and tapes. A general knowledge of the composition, characteristics, intended uses, and methods of application of these materials is very important from both the engineering standpoint and the performance standards required of military packs. Unauthorized or arbitrary selection and use of these materials should be discouraged at all times. Their procurement and distribution should be based on requirements contained in Government specifications and on needs emanating from official mission assignments. A brief discussion of the materials listed above is given in the following paragraphs and tables. Unit containers such as fiberboard, setup, folding and metal-stayed boxes and cartons, cans, drums, etc., are described in chapters 5 and 6.

b. Adhesives. Adhesives is a general term which includes such materials as cement, glue,

Table 3-2. Adhesives Used in Military Packaging

Specification	Title	Uses	Method of application
MMM-A-250....	Adhesives, water-resistant (for closure of fiberboard boxes).	For closure of fiberboard boxes, cartons, and cases. Type I—For application by automatic box closing equipment. Type II—For hand application by brushing. Type III—For hand application, from pressurized container.	Type I—Machine. Type II—Brush. Type III—Aerosol.
MMM-A-260....	Adhesive, water-resistant (for sealing water proofed paper).	For application to seams in the manufacture and closure of waterproof bags, wraps and case liners. Type I—For application by machine. Type II—For hand application. *Class 1*—Solvent-base adhesive. *Class 2*—Water-emulsion adhesive. *Class 3*—Hot-melt adhesive.	Type I—Machine. Type II—Brush.
MMM-A-105....	Adhesive and sealing compounds cellulose nitrate base, solvent type.	Type I—For attaching printed paper labels to shipping containers, also coating the top of labels to make them water resistant. Type II—For repairing and mending articles of glass, metals, leather, china, etc.	Brushing. Brushing.
MMM-A-178....	Adhesive, paper label, water resistant.	One one type, all purpose for application of paper labels to soft wood, fiberboard, black iron, galvanized iron, glass, tin, enamel painted metal, and rubber surfaces.	Brush application. Room temperature.

mucilage, paste, thermoplastic adhesives, etc. These are generally fluid or semifluid materials used to bond two surfaces together by forming, upon setting, a solid or semisolid interface between the two contacting surfaces. The term *adhesive* may be modified by adjectives which describe its physical state, e.g., *liquid adhesive, tape adhesives;* its chemical type, e.g., *silicate adhesive, resin adhesive;* the materials bonded together, e.g., *paper adhesive, can-label adhesive;* or the condition of use, e.g., *hot-setting adhesive, thermoplastic adhesive.* Adhesives may be procured through the General Services Administration. National stock numbers may be found in the Federal supply manuals of the 8040 series. Adhesives must be stored indoors at temperatures ranging from 45°F. to 75°F. Exposure to freezing temperatures reduces their adhesive properties. Length of storage should not exceed 6 months. Information concerning specification symbols, nomenclature, uses, and methods of application of the most commonly used adhesives is given in table 3-2.

c. Bags, Sacks, and Envelopes. Bags, sacks, and envelopes are especially adaptable for the packing of small, lightweight items. The fact that they can be manufactured from transparent stock, can be made waterproof, vaporproof, and greaseproof, can be lined or treated with corrosion inhibiting materials, and can be provided with cushioning effects broadens their application to a large number of items of various types and characteristics. Bags, sacks, and envelopes are generally procured prefabricated and can be stored in a minimum of space. For specific sizes and properties required, the pertinent specifications should be consulted. Available National stock numbers for these containers can be obtained from the following documents: Federal Supply Manuals of the 6850, 7510, 8105, and 8135 series, and the General Services Administration stores stock catalog. Basic information concerning the most commonly used bags, sacks, and envelopes can be found in table 3-7.

(1) *Bags, sleeves and tubing for interior packages.*

(a) Bags used for interior packaging must be made in accordance with the requirements of MIL-B-117. Types, classes and styles are as shown in table 3-3.

(b) Materials shall conform to the types, grades and classes specified in table 3-4.

(c) The bags, sleeves and tubing covered by MIL-B-117 are intended for use as containers to provide various degrees of protection to the contents. Transparent bags are intendeed for use where transparency is desired to facilitate visual inspection of the enclosed product. For the purpose of permitting the maintenance of stocks of bags for quick shipment, common stock sizes are listed in table 3-5.

Table 3-3. Types, Classes & Styles of MIL-B-117 Bags

Type I	—Heavy Duty
Type II	—Medium Duty
Type III	—Light Duty
Class A	—Waterproof, Electrostatic-Free
Class B	—Waterproof
Class C	—Waterproof, Greaseproof
Class E	—Watervaporproof, Greaseproof
Class F	—Watervaporproof, Electrostatic Free
Class G	—Watervaporproof, Greaseproof, Flame Resistant
Style 1	—Opaque
Style 2	—Transparent
Style 3	—One side opaque, other side transparent

1. Class A bags and sleeves are designed for critical items that require electrostatic discharge protection in addition to protection against water penetration and are equivalent to the protection offered by Submethod IC-3 (para 3-20).

2. Class B bags and sleeves are designed as unit packs for items requiring waterproof protection and are equivalent to the protection offered by submethod IC-3 (para 3-20).

3. Class C bags and sleeves are designed as unit packs for items that require greaseproof protection in addition to waterproof protection and are equivalent to the protection offered by Submethod IC-1 (para 3-18).

4. Class E bags and sleeves are designed as unit packs for critical items that require general protection against watervapor penetration in addition to waterproof and greaseproof protection and are equivalent to the protection offered by Submethods IA-8 (para 3-11) and IIc (para 3-27).

5. Class F bags and sleeves are designed for critical items that require electrostatic field force protection in addition to protection against water, water vapor and are equivalent to the protection offered by Submethods IA-8 (para 3-11) and IIc (para 3-27).

6. Class G bags and sleeves are designed for critical items that require flame resistance in addition to protection against water, watervapor and grease penetration and are equivalent to the protection offered by Submethods IA-8 (para 3-11) and IIc (para 3-27).

(d) Limitations as to width of heat seal are as shown in table 3-6.

(e) Net weight of contents should not exceed 10 lbs. except that there are no weight restrictions for the following bags:

(f) Size of bags are unrestricted with the following exception:

Table 3-4. Materials for Fabrication of MIL-B-117 Bags

Classification (MIL-B-117)				Classification (material specification)		
Type	Class	Style	Specification	Type	Grade	Class
I	A	2	MIL-B-81705	II	—	—
I	B	2	MIL-B-22191 L-P-378	III I or II	— A	— 1
I	B	3	MIL-B-22191	III	—	—
I	C	1	MIL-B-121	I	A	1
II	C	1	MIL-B-121	II	A	1
I	C	2	MIL-B-22191	II	—	—
I	C	3	MIL-B-121 MIL-B-22191	I II	A —	1 —
I	E	1	MIL-B-131	—	—	1
I	E	2	MIL-B-22191	I	—	—
II	E	1	MIL-B-131	—	—	3
III	E	1	MIL-B-131	—	—	2
I	E	3	MIL-B-131 MIL-B-22191	— I	— —	1 —
II	E	3	MIL-B-131 MIL-B-22191	— I	— —	3 —
I	F	1	MIL-B-81705	I	—	—
I	G	1	MIL-B-81916	—	—	—

* Finish shall be No. 2 (treated)

** Unless otherwise specified (6.2) nominal thickness inches minimum of L-P-378 shall be .004.

(a) Specification MIL-B-13239 was cancelled 11 Dec. 1978; however MIL-B-117 has not been amended to reflect this change.

Type III, class I, Style 1—450 sq. in. (inside width times inside depth)

Type II, class C, Style 1—50 sq. in. (inside width times inside depth)

(2) Envelopes, packaging, watervaporproof, flexible.

(a) For larger sizes of watervaporproof bags, those conforming to MIL-E-6060, Envelopes, Packaging, Watervaporproof, Flexible, shall be used.

Table 3-5. Common Stock Sizes

Size Designation	Inside dimensions in inches.
1	2½ x 3
2	2½ x 6
3	3 x 5
4	4 x 6
5	4 x 8
6	4 x 12
7	6 x 6
8	6 x 8
9	8 x 12
10	10 x 10
11	10 x 13
12	10 x 12
13	12 x 12

Dimensions are expressed in inches and fractions, width first, length second, as follows: 4" x 6" is a bag 4" wide and 6" long.

(b) The Air Force provides the following specification sheets for fabricating bags for Power Plants:

SPECIFICATION SHEETS

MIL-E-6060/1A(USAF)	Envelope, Packaging, Watervaporproof, Flexible (R-986 and R-1340 Engines)
MIL-E-6060/2A(USAF)	Envelope, Packaging, Watervaporproof, Flexible (R-1820, R-1830 and R-2000 Engines)
MIL-E-6060/3A(USAF)	Envelope, Packaging, Watervaporproof, Flexible (R-2800 Engine)
MIL-E-6060/4A(USAF)	Envelope, Packaging, Watervaporproof, Flexible (5 KW Aircraft Power Plant)
MIL-E-6060/5A(USAF)	Envelope, Packaging, Watervaporproof, Flexible (J-33 Engine)
MIL-E-6060/6A(USAF)	Envelope, Packaging, Watervaporproof, Flexible (0-435 Engine)
MIL-E-6060/7A(USAF)	Envelope, Packaging, Watervaporproof, Flexible (R-4360 Engine)

d. Barrier and Wrapping Materials. A barrier material is a paper like or film material designed to withstand, to a given degree, the penetration of water, water vapor, grease, or certain gases. Barrier materials may serve to exclude or retain such elements within or without the pack. A *wrap* is simply a sheet of flexible material, usually fed from roll stock, and formed around the item or pack to exclude dirt and facilitate handling, marking, or labeling. Barrier and wrapping materials may be divided into two general categories: opaque (nontransparent) and transparent. Opaque barrier materials are especially manufactured *papers* made to resist puncture or tear in shipping and handling, be flexible, waterproof, watervaporproof, greaseproof; or gasproof, or be resistant to flame, tarnish, or mold, if so specified. Some must prevent corrosion, provide protection against penetration by insects, or to be nontoxic, odorless, and tasteless. Practically all must be capable of accepting markings for identification and some must be heat sealable. Transparent films are unsupported, nonfibrous, thin, flexible, basically organic plastic materials, that due to their clearness, protective and shelf-like characteristics, are highly desirable in preservation-packaging operations. Examples of these materials are polyethylene, cellulose acetate, polyester, polystyrene, rubber hydrochloride, vinyl chloride, and chlorotrifluoroethylene. Correct handling of barrier and wrapping materials is a great factor in avoiding inefficient wrapping operations. It is extremely important to receive, store, and handle barrier and wrapping roll stock according to recommended practices. Rolls should be stored on end; flat cuts on their flat surfaces. Temperatures of 45°F. to 75°F., and a relative humidity of 40 percent to 50 percent, are recommended for the storage of most barrier and wrapping materials.

Table 3-6. Heat Seal Width

Area of bag (one side)	Heat seal width maximum	Tolerance—width and length of bag
25 sq in. or less	3/8"	−1/16 + 1/8
26 thru 200 sq. in.	1/2"	−1/8 + 1/4
201 thru 500 sq. in.	5/8"	−1/4 + 3/8
501 sq in. or over	5/8"	−1/4 + 1/2

Seams fabricated by the dielectric, impulse or ultrasonic process shall have a minimum 1/32 inch heat seal. Seams of bags fabricated from unsupported plastic sheet (i.e. polyethylene, polyolefin) shall be required to meet the seam strength test specified in para. 3.4 of MIL-B-117 with no minimum seam width required.

Type	*Class*	*Style*
I	B	2*
I	C	2
I	E	1,2,3
I	F	1
I	G	1

*When using L-P-378 the following applies:

Nominal Thickness	Weight Limitation
.004	up to 5 pounds
.006	over 5 pounds.

The use of dispenser units and automatic splicing equipment will contribute greatly to economy in the use of barrier and wrapping materials. It will also help to maintain a uniform and constant flow of work through the packaging line. Specification symbols, nomenclature, available types, grades, and classes, and intended uses of the most common barrier and wrapping materials are given in table 3-9.

e. Desiccants (Activated). Desiccants are used in connection with Method II preservation and must conform to the requirements of Specification MIL-D-3464. Desiccants are available in three types, Type I—General Purpose; Type II—Nondusting; Type III—For Specific Conditions (8 and 16 units only). The Type II is intended for use in critical packing applications where dusting cannot be tolerated. The Type II is intended for use where a danger exists of accidental flooding by water. The durability of the bag material and seams should be sufficient to prevent contamination of a system by accidental dispersal of desiccant material. Desiccants are furnished in bags of unit size 1, fractional sizes of 1/6, 1/3, and 1/2 of a unit, and multiple sizes of 2, 4, 8, and 16 units. A unit size is that quantity of desiccant which will adsorb at equilibrium with the air and at 77°F. temperature at least the following quantity of water vapor: 3.00 grams at 20 percent relative humidity, and 6.00 grams at 40 percent relative humidity. Desiccant bags shall be secured to prevent movement, possible rupture of bags or barriers or damage to the item. Securing may be accomplished by tying, storage in specially provided baskets, taping, or other approved means. Desiccant bags should be located uniformly throughout the pack and in such a manner that all voids are exposed to the dehydrating action of the material. It is recommended that the total amount of desiccant be in as small unit bag sizes as possible without increasing the cube of the pack. Desiccant bags will not be placed on, or permitted to come in contact with critical surfaces of the packed item. If it becomes necessary to place bagged desiccant in contact with a preservative coated part, the bags shall be isolated by wrapping the coated part with greaseproof barrier material. The minimum quantity of desiccant for use per pack is determined in accordance with Formula I or Formula II of table 3.8 as applicable.

f. Humidity Indicators. Humidity indicators shall be used in method II packs, unless otherwise specified. As applicable, the indicator shall be located behind inspection windows or immediately within the closing edge, face or cover of the barrier, and as far as practicable from the nearest unit of desiccant. Humidity indicators used within sealed packs shall conform to Military Standard MS 20003 (Indicator, Humidity, Card, Three-Spot Impregnated Areas) (fig. 3-2). This indicator is a three-spot paper card type, 2x4 inches in size. The spots indicate relative humidities of 50 percent, 40 percent and 30 percent, top to bottom, by changing color from blue to pink. This indicator is accurate within 5 percent of the aforementioned relative humidities. Desiccant type humidity indicators will be subject to approval of the procuring agency (fig 3-2). Externally mounted indicating elements or devices such as the plug type (fig 3-2), when specified, shall be installed in place of, or when required, in addition to the humidity indicators conforming to Military Standard MS 20003. Externally mounted color change indicators, unless otherwise specified, will conform to Specification MIL-I-26860 (Indicator,

Table 3-7. Bags, Sacks, and Envelopes Used in Military Packaging

Specification	Title	Type, grade, or class	Uses
MIL-B-22020	Bags, transparent, flexible heat sealable, volatile corrosion inhibitor treated.	One type with the following size designations, unless otherwise specified, with width first and length second: 1-2½ in. x 3 in. 2—2½ in. x 6 in. 2a—3 in. x 5 in. 3—4 in. x 8 in. 4—4 in. x 12 in. 5—6 in. x 8 in. 6—8 in. x 12 in. 7—10 in. x 13 in.	For use in packaging of items that are adaptable to protection by volatile corrosion inhibitor treated materials. Bags shall be used in accordance with Specification MIL-I-8574.
MIL-B-40028	Bags, barrier, with volatile corrosion inhibitor treated liners.	Type 1—General purpose (rectangular). Type II—Special purpose. Class A—Heavy duty. Class B—Medium duty.	*Types I and II*—For use in packaging items that are adaptable to protection by volatile corrosion inhibitor treated materials. (Type I bags shall be fabricated in accordance with Class E bags of MIL-B-117. Type II bags shall be fabricated in accordance with the applicable drawing or contract.)
PPP-S-30	Sacks, shipping, paper (cushioned).	Type I—Exterior packaging. Type II—Interior packaging. *Note*: Sacks may range from 4 to 20 inches in width and 8 to 40 inches in length for items weighing no more than 10 pounds.	*Type I*—For shipment of publications and small parts where a light cushioning effect and water resistance are required. *Type II*—For interior packaging of fragile items such as bottled liquids, radio tubes, and testing and laboratory equipment.
MIL-E-6060	Envelopes, packaging, water-vaporproof, flexible.	One type only	*Generally*—For packaging of items requiring maximum water-vaporproofing protection under Methods IA & II. *Specifically*—For floating bag application (submethods IA-16 and IIa); for containers having two dimensions over 36"; or for packages containing inspection windows.
MIL-B-81997	Pouches, cushioned, flexible, electrostatic-free reclosable transparent.	Type I—Three-Ply Wall; Two Outerplies—Barrier Electrostatic-Free Transparent; Inner Ply-Cushioning, Electrostatic-Free Transparent; Type II—Single Ply: Cushioning-Electrostatic-Free Transparent.	For packaging and storing static-sensitive electronic devices.

Table 3-8. Minimum Quantity of Desiccant per Unit Pack

Formula I—To find units of desiccant for use within barrier other then sealed rigid metal barrier: $U = CA + X_{(1)} D + X_{(2)} D + X_{(3)} D + X_{(4)} D$

Formula II—To find units of desiccant for use within sealed rigid metal barrier: $U = KV + X_{(1)} D + X_{(2)} D + X_{(4)} D$

In the above formulas:

U = Number of units of desiccant to be used.
C = 0.011 when area of barrier is given in square inches.
C = 1.6 when area of barrier is given in square feet.
A = Area of barrier in square inches or square feet.
K = 0.0007 when volume is given in cubic inches.
K = 1.2 when volume is given in cubic feet.
V = Volume within barrier in cubic inches or cubic feet.
D = Pounds of dunnage (other than metal) within barrier.
$X_{(1)}$ = 8 for hair felt, cellulosic material (including wood) and other material not categorized below.
$X_{(2)}$ = 3.6 for bond fibers (animal hair, synthetic fiber and vegetable fiber bound with rubber).
$X_{(3)}$ = 2 for glass fiber.
$X_{(4)}$ = 0.5 for synthetic foams and rubber.

Note—Use only the X factors for material used in fabrication of the unit pack being considered.

Formula II may be used to determine units of desiccant required for sealed rigid containers (other than all-metal) when the sealed barrier provides a MVTR not exceeding 0.001 grams per 24 hours per 100 square inches, as established by Government specification or when tested in accordance with ASTMD 895.

Area $(A) = L \times W$
L = Length of barrier material to be used to fabricate pack.
W = Width of barrier material to be used to fabricate pack.

Volume $(V) = \pi r^2 h$
π = 3.1416
r = Radius of can (½ distance across top)
h = Height or length of can

Humidity, Plug, Color Change). This is a metal plug type indicator which is permanently calibrated, reacts quickly to humidity changes, and is used for determining relative humidity within rigid containers and flexible watervaporproof barriers. Plug type indicators change from blue to pink at 40 percent relative humidity. When used with pressure or vacuum containers, they will hold up to 20 pounds per square inch differential air pressure. Advancements in plug type indicators have produced one that provides positive and permanent indication of early moisture entry before corrosion takes place. These "Irreversible Relative Humidity Indicators" trip (stain) at a set relative humidity (usually 55%) and are [illegible] reset by temperature or sunlight.

g. Inspection Window. Windows are installed in the barrier material of some packs to permit inspection of the interior of the pack. These windows shall conform to Specification MIL-W-10434 or Type I of MIL-B-22191 and, when in place, should coincide with the location of a removable inspection port when provided in the exterior container. These windows come in two classes. Class 1 is a watervaporproof window. Class 2 is a waterproof window. They are generally rectangular in shape and the effective transparent area varies from 32 square inches to 64 square inches. These windows are applied to flexible watervaporproof barriers during the initial fabrication of the pack. Class 1 windows are applied mainly to submethod IIa and IA-16 packs to observe either the humidity indicator or the item within the package. Class 2 windows are intended for method IC packs to observe the condition of the item within the pack. Cement for securing the gaskets that hold the window to the barrier shall conform to Specification MMM-A-1617. The installation of a window is illustrated in figure 3-3.

h. Labels. Paper labels are often used to apply identification and special markings to containers. Required markings on labels for interior packs shall be printed, typed, or reproduced. The size of labels and the lettering shall be consistent with the size of the pack, and the lettering shall be of a size which will permit ready identification. Pressure sensitive and heat activated, plastic coated labels may be used in lieu of paper labels on interior packs. Labels for Level A packs will be secured with water-resistant label adhesive conforming to Specifications

Table 3-9. Barrier and Wrapping and Materials Used in Military Packaging

Specification	Title	Type, grade, or class	Uses
MIL-B-121................	Barrier material, greaseproofed, waterproofed, flexible.	*Type I—Heavy Duty* Grade A—Greaseproofed, waterproofed, and non-corrosive. Class 1—Heat Sealable, nonstretchable. Class 2—Nonheat sealable, stretchable. Grade C—Greaseproofed, waterproofed noncorrosive, moldable, and self-adhering. Class 1—Self-adhering coating applied on nongreaseproof side only. Class 2—Self-adhering coating applied on both sides. *Type II—Medium Duty* Grade A—Greaseproofed, waterproofed, and noncorrosive. Class 1—Heat sealable, nonstretchable. Class 2—Nonheat sealable, stretchable.	*General*—This material is used for protection of military supplies and equipment during transportation and storage under all types of climatic conditions. *Grade A material*—Grade A, class 1 material is primarily used in the fabrication of greaseproofed, waterproofed packaging bags and also as an intimate wrap instead of Grade A, Class 2 material. Grade A, class 2 material is essentially used as an intimate wrap to maintain and protect coatings of oily or soft preservatives in contact with metal surfaces to which applied. It is also used where it is necessary to insulate the metal surface of packaged items from hygroscopic or corrosive elements of the pack where contact of required outer wraps of other barrier materials would contaminate the metal surfaces of the packaged item; or where other more protective barrier materials are not required. *Grade C material*—Grade C material is used primarily as an outer wrap of boxed or unboxed preserved material and usually sealed by a waxdip coating over the closed wrap. Grade C, class 1 material only may be used as an intimate wrap for critical items preserved with oily or soft preservatives since the surface of the wrap in contact with critical surfaces is noncorrosive and free of transferrable material.
MIL-P-130................	Paper, wrapping, laminated and creped.	Type I—Heavy. Type II—Medium duty. Type III—Light duty.	As a protective cover or wrap over Grades A and C, MIL-B-121, barrier material; as an intimate wrap on nonprecision parts where greaseproofness is not required; as a wrap on parts or articles where a carton would waste shipping space; as a protective band around the outer surface of cylinders on completed radial-type engines; and as a complete cover for in-line-type engines. Not intended for use as a substitute for waterproof barrier materials.
MIL-B-131................	Barrier material; water-vaporproof, flexible, heat sealable.	Class 1—Plastic and nonwoven Class 2—Kraft (limited use) Class 3—Serion (woven fabric)	*Class 1*—For use in packaging operations where heat-sealable, flexible, water-vaporproof barrier materials are required. *Class 2*—Suitable for use in packages where the combined weights inside the barrier does not exceed 10 pounds. For all practical purposes, class 2 materials should be limited to use in bags whose inside length

Table 3-9.—Continued

Specification	Title	Type, grade, or class	Uses
			plus width does not exceed 42 inches. Class 2 materials should not be used in floating bag applications, in packaging operations under low temperature conditions (below 32° F) where fabrication or manipulation of the material is required, or where a double seam junction is fabricated. *Class 3*—Same as class 1, but to be used where a serion (woven fabric) backing is required.

Table 3-9.—Continued

Specification	Title	Type, grade, or class	Uses
MIL-P-17667	Paper, wrapping, chemically neutral (noncorrosive).	Type I—Flat. Type II—Creped (furnished in the following classes); Class 1—Creped in one direction. Class 2—Creped in two directions, or creped in one direction and corrugated in the other.	Intended for use as an initial wrap on items requiring a non-corrosive, dust protective wrap applied prior to, or as a part of unit packaging, where a greaseproof wrap is not required. *Note.* Not intended as an antitarnish paper for silver and magnesium.
MIL-F-22019	Film, transparent, flexible heat sealable, volatile corrosion inhibitor treated.	One type only.	For use primarily in short term protection of items where transparency is desired to facilitate inspection and identification. Use in accordance with Specification MIL-I-8574.
MIL-B-22191	Barrier material, transparent, flexible, heat sealable.	Type I—Water-vaporproof, greaseproof, waterproof. Type II—Waterproof, greaseproof. Type III—Waterproof.	Type I—For use in packaging applications where water vapor impermeability is required. Type II—For use in packaging applications where either or both greaseproofness and waterproofness are required. Type III—For use in packaging applications where protection against solid contamination and water is required.
MIL-B-81374	Barrier material, greaseproof, waterproof, flexible, high strength.	One type only.	For use where a high strength, durable, flexible, waterproof, greaseproof, heat sealable material is required. Used as an interior wrap and for the fabrication of envelopes for general purpose packaging of military parts and equipment. It can be utilized to advantage for the packaging of high density items.
MIL-B-81705	Barrier materials, flexible, electrostatic free water-vaporproof, heat sealable.	Class 1—Oil resistant. Class 2—Nonoil resistant.	To fabricate enclosures primarily for missiles stored, handled, and transported in cradles and subjected to direct climatic exposure during logistic flow. Especially formulated to prevent the buildup or retention of electrostatic potential under any atmospheric conditions.
L-P-378	Plastic sheet and strip, thin gauge, polyolefin.	Type I—Normal impact strength polyethylene. Type II—High impact strength polyethylene. Type III—Polyproplene. Type IV—Heat shrinkable polyethylene. Class 1—For nonfood contact application. Class 2—For use in contact with food. Class 3—Biaxially oriented. Class 4—Preferentially oriented.	Intended for use in general purpose packaging applications where high degree of water resistance, moderate moisture vapor, resistance, and dust protection are desired. It is not intended for use in special packaging applications where special grease or oil resistance properties may be required.
QQ-A-1876.	Aluminum foil.	Type I—Rolls. Type II—Interfold flat sheets. Class 1—Flat sheets, 12 × 10¾ inches. Class 2—Flat sheets, 9 × 10¾ inches. Type III—Single-ply flat cuts (size to be specified in the contract or order). Grade A—For food handling and processing application.	As a noncorrosive barrier between surfaces which have been coated with preservative compounds and wood or dunnage, or between treated surfaces and other surfaces which would cause corrosive action. *Caution:* Direct contact with metals other than cadmium, aluminum, magnesium, or zinc should be avoided in application which may be exposed to water, to prevent galvanic action.

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Table 3-9.—Continued

Specification	Title	Type, grade, or class	Uses
		Grade B—For application other than food handling or processing.	
UU-P-268.........	Paper, Kraft, untreated, wrapping.	Grade A—No. 1 Commercial designation. Grade B—No. 2 Commercial designation.	For general use in the overwrapping of packages where a chemically neutral or greaseproof, waterproof, or vaporproof barrier is not required.
UU-P-553.........	Paper, wrapping tissue.	Type I—Regular. Class 1—Bleached. Class 2—Unbleached. Type 2—Neutral (antitarnish) Class 1—Bleached. Class 2—Unbleached.	Type I is used as an initial wrap to protect items from breaking, scratching, and dusting during shipment and storage. Type II, in addition to the use requirements of type I, is used to prevent tarnishing.
PPP-B-1055.......	Barrier material, waterproofed, flexible.	Classes: B-1—Baling and interior wraps. B-2—Baling and interior wraps. B-3—Baling and interior wraps. C-1—Interior wraps. C-2(a)—Crate liners and interior wraps. E-1—Interior wraps and crate liners. E-2—Interior wraps, crate liners, shrouds, and baling. H-1—Case liners, shrouds, and crate liners H-2—Case liners. H-3—(a)—Case liners. H-4—Case liners. H-5—Case liners, shrouds, and crate liners. L-2(b)—Case liners and crate liners. L-4—Temporary tarpaulins. M-1—Case liners, shrouds, and crate liners.	Bailing—Classes B-1, B-2, -3, and E-2. Interior wraps—Classes C-1, C-2(a), E-1, and E-2. Case liners—Classes H-1, H-2, H-3(a), H-4, H-5, L-2(b), and M-1. Crate liners—Classes C-2(a), E-1, E-2, H-1, H-5, L-2(b), and M-1. Shrouds—Classes E-2, H-1, H-5, and M-1. Temporary tarpaulins—Class L-4.

MMM-A-105, MMM-A-178, or MMM-A-179. Label for Level B packs will be secured with adhesive in accordance with commercial practice. When the level of packing is not known, label securing requirements for Level A will apply.

i. Tapes. A tape is an adhering, narrow strip or band of paper, textile, plastic, etc., which has several applications in military packaging, among them the closing and sealing of containers. On the basis of the nature of the adhesive applied to the backing material of tapes, those used predominantly by the military fall into two major categories: pressure-sensitive tapes and water-activated tapes (gummed tapes). Pressure-sensitive tapes are those which in the dry (solvent-free) form are highly and permanently tacky at room temperature, and firmly adhere to surface upon mere contact and without the need of more than slight finger or hand pressure. Water-activated tapes are those which require activation of the adhesive by water before the tapes can exert their adhesive holding power. Tapes should be stored in clean, dry places. Storage temperatures of 70°F. to 75°F. are recommended. Tapes should be stored in their original containers, and purchases should be adjusted to avoid storage for more than 6 months. All tapes, especially pressure-sensitive tapes, should be stored so that the pressure is exerted against the edge of the tape. Tapes which have been stored for over 1 year should be examined carefully before use, and if there is any evidence of deterioration, such as separation of layers within the roll, tape adherence to its own backing, or stringy appearing adhesive when the tape is unrolled, the tape should be replaced. National stock numbers for requisitioning tapes are found in the Federal Supply Manuals of the 7510 and 8135 series. Specification symbols, nomenclature, available types, grades, and classes, and intended uses of the most common tapes are given in table 3-10.

3-5. Cushioning Materials and Their Application

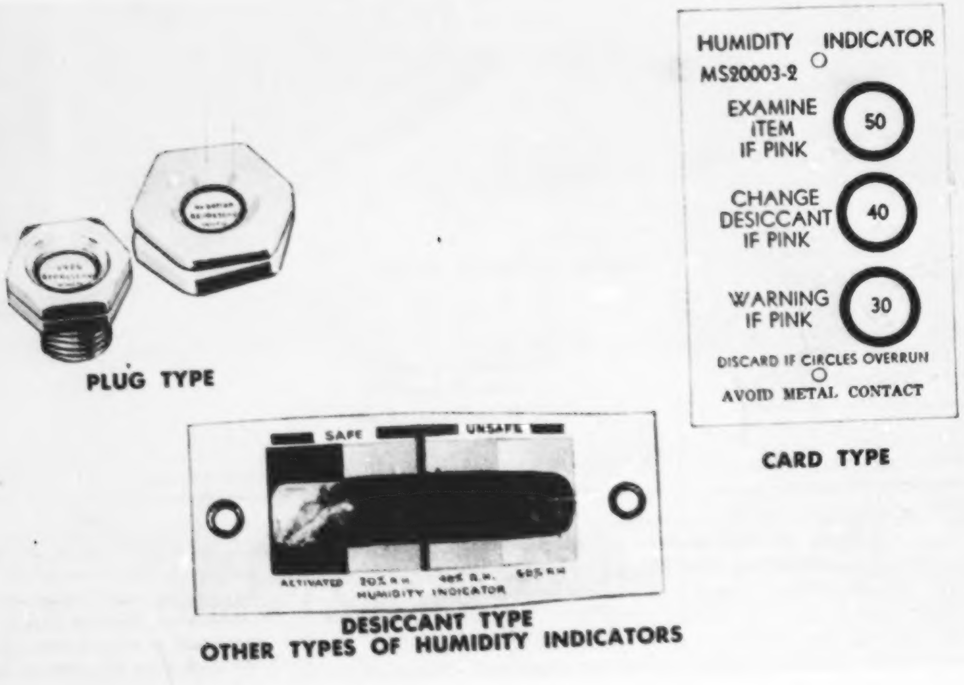
a. Concept of Cushioning. Cushioning is the protection from physical and mechanical damage afforded an item by means of compressible and resilient materials, known as cushioning materials, designed to absorb the energy of shocks and vibration caused by external forces.

b. Functions of Cushioning. In order to utilize properly the many cushioning materials available in the military supply system, it is necessary to understand the functions of cushioning. Among these functions (fig. 3-4), the more important are—

(1) *Control item movement.* Cushioning, when properly applied, controls the movement of the item within the barrier or container and mitigates the effects of shock and vibration.

(2) *Protect fragile or delicate components.* When fragile or delicate components form a part of an otherwise rugged item, they may be disassembled and packed separately. If disassembly is not permitted and they must be left in place, cushioning is applied to give them protection.

(3) *Prevent rupture of barriers and containers.* Many items have sharp corners or projections which could puncture the barriers or containers in which they are packed, resulting in the entry of moisture or water. Cushioning is applied to these projections or corners to insure that waterproof or water-vaporproof barriers are not rendered useless by such damage.


HUMIDITY INDICATOR
MS20003-2
EXAMINE ITEM IF PINK
50
CHANGE DESICCANT IF PINK
40
WARNING IF PINK
30
DISCARD IF CIRCLES OVERRUN
AVOID METAL CONTACT
SAFE
UNSAFE
ACTIVATED
30% R.H
40% R.H.
60% R.H
HUMIDITY INDICATOR
JMPTC 3278

PLUG TYPE

CARD TYPE

DESICCANT TYPE

OTHER TYPES OF HUMIDITY INDICATORS

Figure 3-2. Humidity indicators.

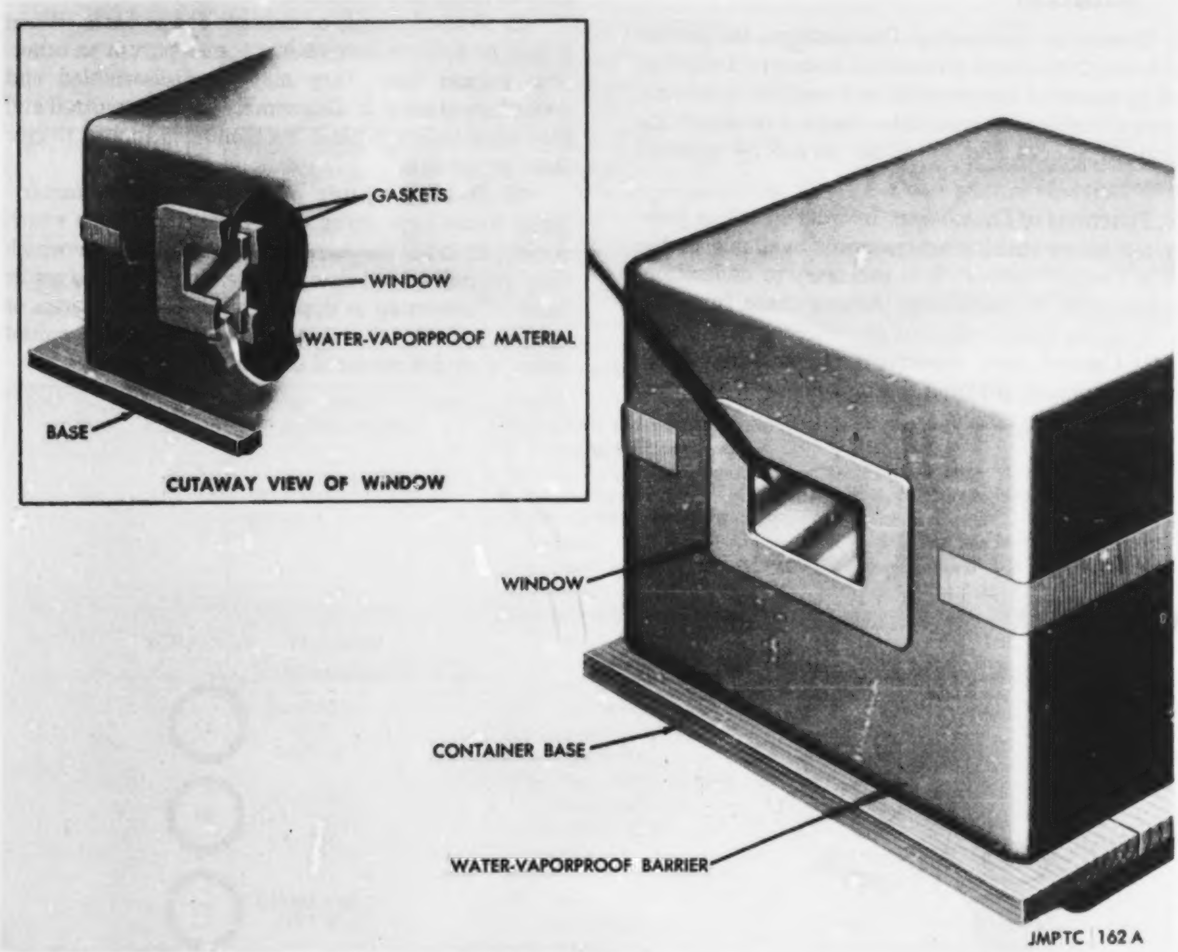

GASKETS
WINDOW
WATER-VAPORPROOF MATERIAL
BASE
CUTAWAY VIEW OF WINDOW
WINDOW
CONTAINER BASE
WATER-VAPORPROOF BARRIER
JMPTC 162 A

Figure 3-3. Inspection windows.

Table 3-10. Tapes Used in Military Packaging

Specification	Title	Type, grade, or class	Uses
L-T-99	Tape, pressure-sensitive, adhesive, identification.	Type I—Interior labeling and identification. Type II—Edging. Type III--Exterior labeling and identification.	Type I. For interior use as an identification medium. In the printed form it may be used for labeling applications including files, containers of all types, charts, etc. Colored tape, with or without printing can be used for identifying the metal in metal shapes, color coding, etc. It is not recommended for edging purposes. Type II. For edging of documents; maps, charts, etc., to protect the edges from tearing or other damage during handling and storage. Type III. For both interior and exterior identification applications such as Air Mail Tape and other special markings required in packaging. Office use and similar applications. It is not recommended for edging purposes.

Table 3-10.—Continued

Specification	Title	Type, grade, or class	Uses
PPP-T-42	Tape, Packaging, Masking, Paper	Type I—Crepe. Type II—Flat.	For light duty bundling, holding, and packaging applications such as bundling small parts to be over-packed, holding small parts to larger assemblies, and for temporary closing of chipboard and fiberboard boxes that are *not* to be shipped.
PPP-T-45	Tape, gummed, paper, reinforced and plain, for sealing and securing.	Type I—Reinforced, asphalt laminated. Class 2—Nonstrippable. Type II—Reinforced, nonasphaltic laminated. Class 1—Strippable. Class 2—Nonstrippable. Type III—Plain, single ply. Class 2—Nonstrippable. Grade A—Light duty. Grade B—Medium duty. Grade C—Heavy duty.	*Types I and II*—For use in "single strip" closure under UFC, Rule 41, Section 7. Used for closure of fiberboard boxes for domestic shipment and storage, and for securing wrappers of packages. (Note 1) Type II should be used where presence of asphalt would have deleterious effect on the item, such as food products. *Classes 1 and 2*—Class 1 intended for use where ease of opening and removal of tape is required. Class 2 is intended for use where it is not necessary to remove tape from boxes for reuse. *Type III*—For general sealing of cartons and fiberboard boxes, wrappers of packages and banding of paper and paper products.
PPP-T-60	Tape, Packaging waterproof	Type III—Film backing. Class 1—Colored. Class 2—Transparent. Type IV—Woven cloth backing. Class 1—Colored.	For packaging application requiring waterproof pressure-sensitive adhesive tape, according to the following: *Class 1*—Where high strength characteristics and maximum resistance to rain, sunlight and other deteriorating elements are required. *Class 2*—For packaging of supplies which are over-packed in exterior containers where high strength characteristics are not required and transparency is desired. *Class 3*—For packaging of supplies which are over-packed in exterior containers when high strength and transparency are not required. (Note 1)
PPP-T-66	Tape, Packaging, vinyl plastic film.	Type I—General Purpose. Class 1—Transparent. Class 2—Colored. Type II—Printable.	Both types I and II are intended for uses such as sealing out moisture and applications requiring the flexibility, toughness, and conformability normally possessed by a plasticized vinyl film.
PPP-T-76	Tape, packaging, paper (for carton sealing).	One type only	For water resistant applications in packaging and packing; for closing and sealing fiberboard containers. (Note 1)
PPP-T-97	Tape, pressure-sensitive adhesive, filament reinforced.	Type I—Low tensile strength. Type II—Medium tensile strength. Class A—Opaque. Class B—Transparent. Type III—High tensile strength. Type IV—High tensile strength weather resistant.	*Type I*—For strip reinforcement of containers and anchoring moving parts. *Type II*—For closures. *Type III*—For bundling and other forms of circumferential binding. *Type IV*—Where weather resistance is required. (Note 1)
L-T-90	Tape, pressure-sensitive adhesive (cellophane and cellulose acetate).	Type I, Class A—Cellophane, transparent. Type I, Class B—Cellophane, colored. Type II, Class A—Cellulose acetate, transparent, low reflectance.	*Type I, Class A*—For nonpermanent applications such as holding, covering light packaging, sealing, shielding, and general office use. *Type I, Class B*—For nonpermanent applications such as identification, charting, decorating, holding, light packaging, and sealing.

Table 3-10.—Continued

Specification	Title	Type, grade, or class	Uses
		Type II, Class B—Cellulose acetate, transparent, glossy backed.	*Type II, Class A*—For permanent mending of paper, documents, blueprints, maps, etc. *Type II, Class B*—For permanent applications such as light holding, covering, shielding, and sealing.
MIL-T-22085	Tapes, adhesive, preservation and sealing.	Type II—For use without overcoating. Type III—For use with overcoatings.	Type II—For use in the preservation and sealing of military vehicles, airplanes, missile and other related equipment where long term exterior exposure is anticipated. No overcoating is required to protect the tape. Type III—For the same application as Type II tape except the tape must be overcoated with strippable, sprayable coatings such as those covered by MIL-C-6799 if exterior exposure is to exceed 90 days. Type III tape may be used without overcoating for the sealing of equipment that may have shed or indoor storage.
MIL-T-43036	Tape, pressure-sensitive adhesive, plastic film, filament reinforced (for sealing fiber containers and cans).	One type only................	For sealing fiber containers and cans meeting MIL-C-2439 and MIL-C-3955 and for slip cover metal containers. It may be used in other applications where waterproof, watervaporproof, medium tensile strength tape possessing good low temperature removal properties is required.

Note 1.—See FED-STD-224, Closing, Sealing, and Reinforcing of Fiberboard Shipping Boxes, General Methods For, and PPP-B-636, Boxes Shipping, Fiberboard for Closing, Sealing, and Reinforcement Instructions.

(4) *Distribute forces.* Cushioning materials reduce the effects of impact shock to an item by distributing the damaging forces over a large area, this lowering the energy concentration at any one point on the surface of the item.

(5) *Prevent abrasion.* Items with highly finished surfaces which may be marred by blocking, strapping, contact with other items in the container, must be protected against abrasion by cushioning. Usually, lesser amounts and thicknesses of cushioning materials are employed to accomplish this cushioning function.

(6) *Absorb shocks.* Perhaps the most frequent and important use of cushioning is to absorb the energy resulting when a container is subjected to impact. This shock energy is absorbed as the cushioning material is compressed by the item.

(7) *Multipurpose cushioning.* Although the foregoing characteristics of cushioning are described separately, in practical application most materials used for cushioning serve more than one function. A material selected to protect an item from damage by impact shock may also prevent abrasion, protect barrier materials and cover sharp projections. Another material may serve to distribute shock forces as well as limit movement. Some materials serve as rigid blocking with limited shocks and as flexible cushioning with more severe shocks. Cushioning materials may also be required to absorb liquids, in case the inner container becomes damaged and leaks. This is particularly required for liquids which are corrosive or otherwise dangerous.

c. *Requirements for the Use of Cushioning Materials.* In addition to the requirements established in cushioning specifications which control material quality, construction, and performance, three important requirements must be met when cushioning materials are used within waterproof or water-vaporproof barriers. Military Specification MIL-P-116 required that—

(1) Cushioning be as dry as practicable.

(2) Cushioning must be noncorrosive.

(3) If the item is coated with a preservative, the preserved item must first be wrapped in a greaseproof barrier conforming to Grade A of MIL-B-121, QQ-A-1876, or Type II of MIL-B-22191. In addition, material conforming to Type III of MIL-B-22191 may also be used as cushioning and dunnage when bags are made of material conforming to Grade A of MIL-B-121, MIL-B-131, or Type II of MIL-B-22191.

d. *Cushioning Selection Factors.* There are several factors that must be considered in selecting the appropriate cushioning material for a given application. The nature and physical limitations of the item, the favorable and unfavorable characteristics of the cushioning material, the destination of the packs, and the means

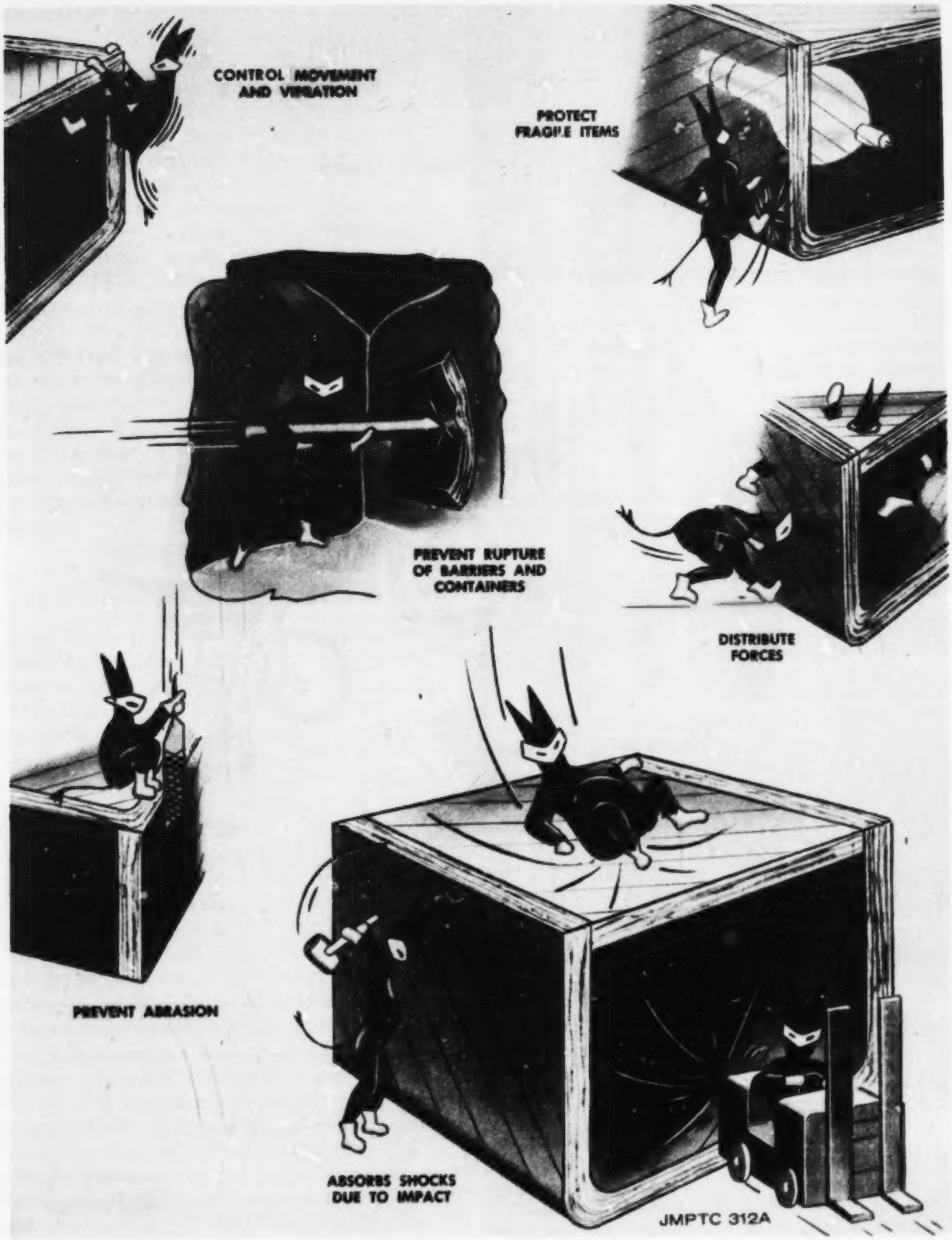
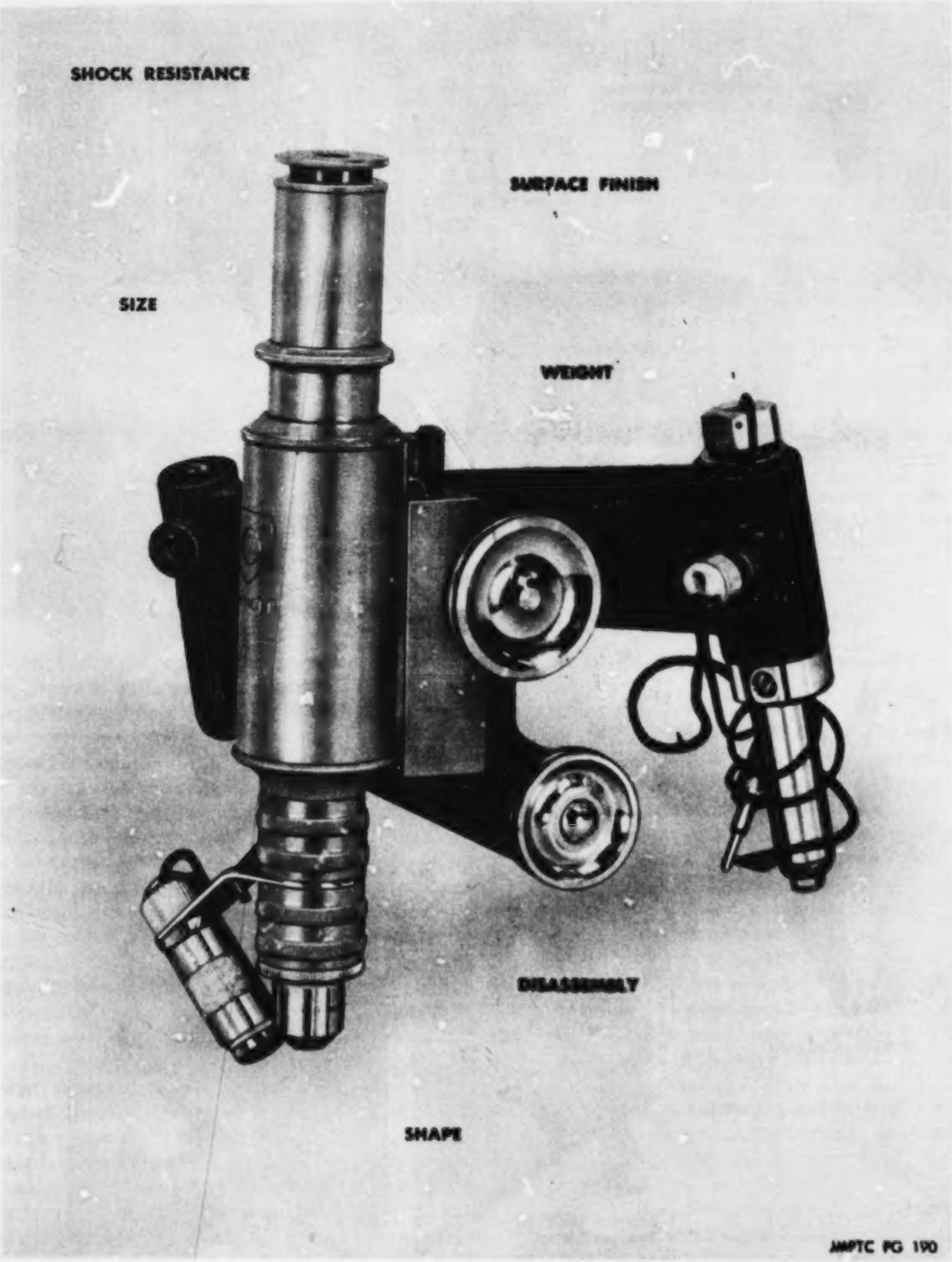

CONTROL MOVEMENT AND VIBRATION
PROTECT FRAGILE ITEMS
PREVENT RUPTURE OF BARRIERS AND CONTAINERS
DISTRIBUTE FORCES
PREVENT ABRASION
ABSORBS SHOCKS DUE TO IMPACT
JMPTC 312A

Figure 3-4. Functions of cushioning.


SHOCK RESISTANCE
SURFACE FINISH
SIZE
WEIGHT
DISASSEMBLY
SHAPE

JMPTC PG 190

Figure 3-5. Item characteristics which determine the selection of cushioning material.

of transportation must all be taken into consideration before an item can be properly cushioned.

(1) *Characteristics of the item.* In planning to cushion an item, the nature and physical limitations of the item must first be considered. The shock resistance, size, weight, shape, surface finish, and the degree of disassembly permitted will influence the way an item is to be cushioned (fig 3-5). Design data such as specifications and/or drawings are excellent sources for this information.

(a) *Shock resistance or fragility.* Fragility cannot be determined by eye alone. The tendency is to over-cushion seemingly fragile items and to under-cushion seemingly sturdy items. Fragility-the greatest amount of energy an item can withstand without destruction-can be measured with scientific instruments. The term "G-factor" has been accepted as indicating the shock resistance of an item. This resistance is determined by fragility testing in which an item is subjected to impact shocks of increasing severity. The minimum deceleration of the item at which damage or malfunction occurs divided by the acceleration due to gravity is called the "G-factor" for that item. This is expressed as:

$$\text{G-Factor} = \frac{\text{Acceleration}}{\text{Gravity}}$$

The G-factor values of many military items are being determined. In the absence of known G-factor values, the determination of the right cushioning must be based on the history of previous shipments and, whenever practicable, on actual drop testing of the completed pack.

(b) *Size.* A large item may require a thinner layer of cushioning than a smaller item of the same weight because there is less load per square inch applied to the cushioning. This should be kept in mind when an item is irregular in shape—more cushioning may be required at the small end than at the large end.

(c) *Weight.* Weight in motion results in force, and force can cause damage. Thus, the weight of an item controls the thickness, quantity, and firmness of the cushioning material to be used. Generally, the heavier the item, the firmer the cushioning must be.

(d) *Shape.* A regular-shaped item will ordinarily fit snugly into a container with a minimum of cushioning, while an irregular-shaped one may require a complicated arrangement of pads and cells or foamed-in-place cushioning to bring it up to a more regular shape. Light, small items which are irregular in shape can be made regular and at the same time positioned and held in the container merely by a wrap of cushioning material. Large, irregular items may make it impractical to use cushioning materials to make them regular. Blocking and bracing in conjunction with cushioning will have to be employed to protect such items.

(e) *Static stress.* Tables of cushioning performance factors usually present data based on static stress (the weight per unit area). This is determined by dividing the weight in pounds by the area of the weight bearing surface in contact with the cushioning.

(f) *Surface finish.* An otherwise sturdy item may have highly finished surfaces which could be damaged by the rubbing action of harsh abrasive cushioning material, or the surface may be corroded and pitted by chemical action due to the presence of moisture and acidic or basic elements in the cushioning material.

(g) *Disassembly.* The disassembly of a highly irregular item may allow a reduction in its cube and permit simpler cushioning to give the necessary protection. Before disassembly, however, competent advice should be obtained as to the feasibility of reassembly and calibration, if necessary, in the field.

(2) *Characteristics of cushioning materials.* The chemical and physical properties of cushioning materials are many and many display both desirable and undesirable characteristics. These characteristics vary in importance for different applications. What might be a highly desirable characteristic in one application, may be detrimental in another. The hygroscopic characteristic of some materials is to absorb water from the atmosphere. High moisture absorbency is required for packing liquids, but is not desirable when packing corrodible metal items.

(a) Compression set (fig 3-6) is the difference between the original thickness of a cushioning material and the thickness of the same material after having been released from compression. Compression set is undesirable as it creates free-moving space in the container.

(b) Resilience (fig 3-6) is the ability of a material to absorb a series of shocks and return to its original shape and thickness after each shock. Fewer materials are completely resilient and this quality is often greatly altered by changes in temperature. Rubber, for instance, is highly resilient in temperate zones, but loses its resilience under extreme cold conditions, unless altered by additives.

(c) Rate of recovery (fig 3-6), or the time it takes for a cushioning material to return to its original shape after compression, is also important as some materials have too rapid a rate of recovery and "spring back" so quickly that damage to the item may result.

(d) Dusting, which results from the breakdown and disintegration of certain materials used for cushioning, allows small particles to become detached and work into crevices and critical working surfaces of the cushioned item (fig 3-7).

(e) The corrosive effect of some cushioning ma-

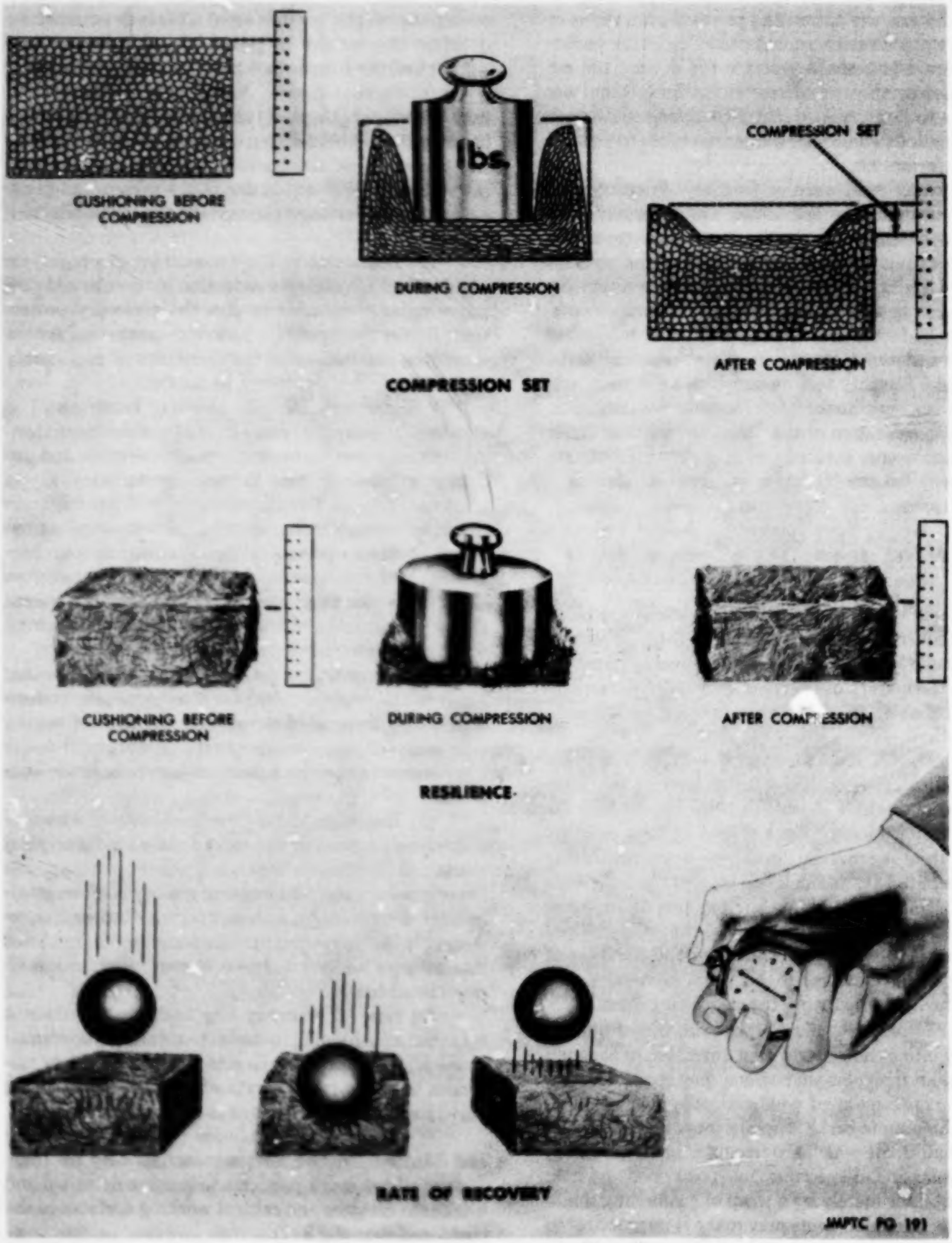

CUSHIONING BEFORE COMPRESSION
lbs.
DURING COMPRESSION
COMPRESSION SET
AFTER COMPRESSION
COMPRESSION SET
CUSHIONING BEFORE COMPRESSION
DURING COMPRESSION
AFTER COMPRESSION
RESILIENCE
RATE OF RECOVERY
JMPTC PG 191

Figure 3-6. Characteristics of cushioning materials-compression set, resilience, and rate of recovery.

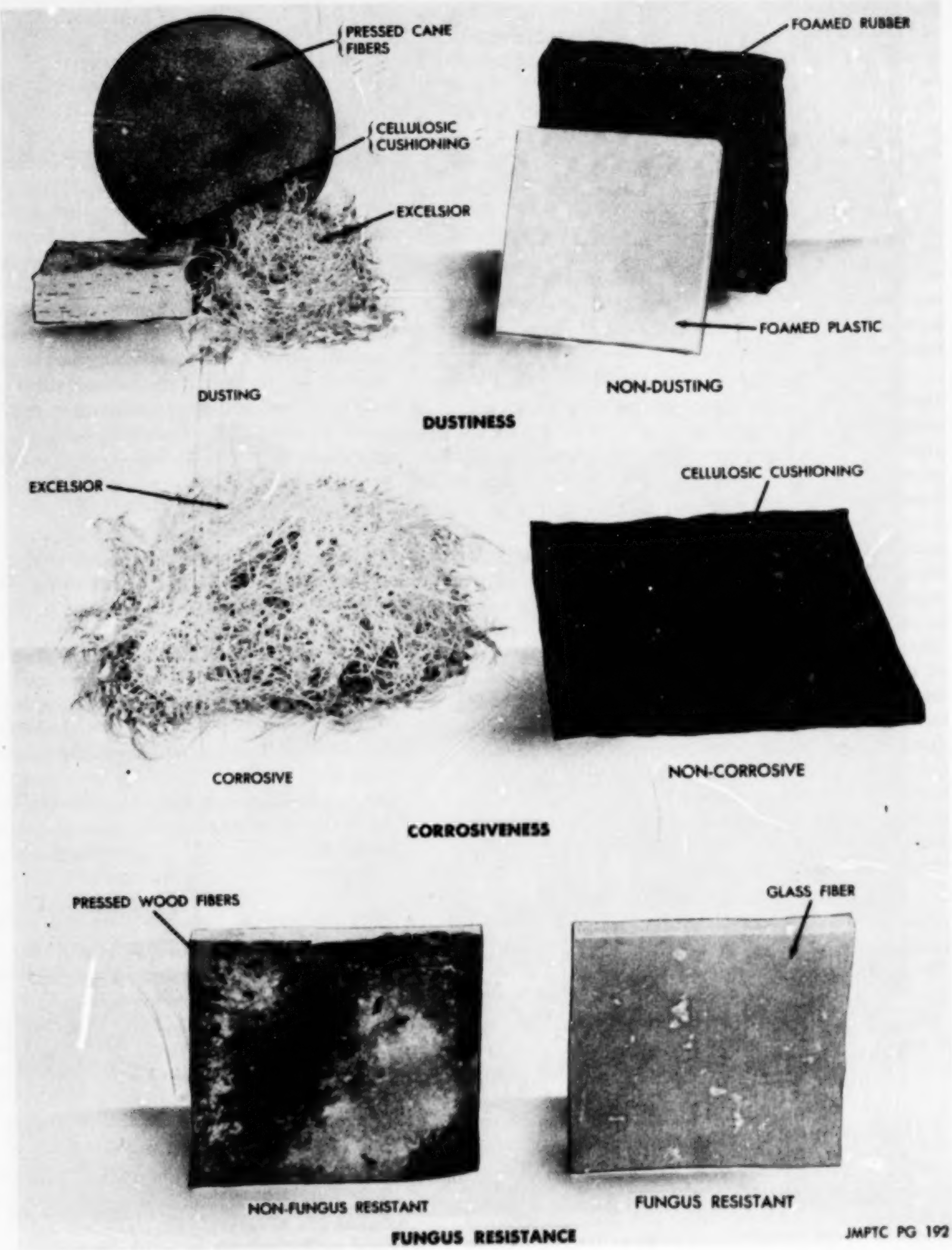

PRESSED CANE FIBERS
CELLULOSIC CUSHIONING
EXCELSIOR
FOAMED RUBBER
FOAMED PLASTIC
DUSTING
NON-DUSTING
DUSTINESS
EXCELSIOR
CELLULOSIC CUSHIONING
CORROSIVE
NON-CORROSIVE
CORROSIVENESS
PRESSED WOOD FIBERS
GLASS FIBER
NON-FUNGUS RESISTANT
FUNGUS RESISTANT
FUNGUS RESISTANCE
JMPTC PG 192

Figure 3-7. Characteristics of cushioning materials-dustiness, corrosiveness, and fungus resistance.

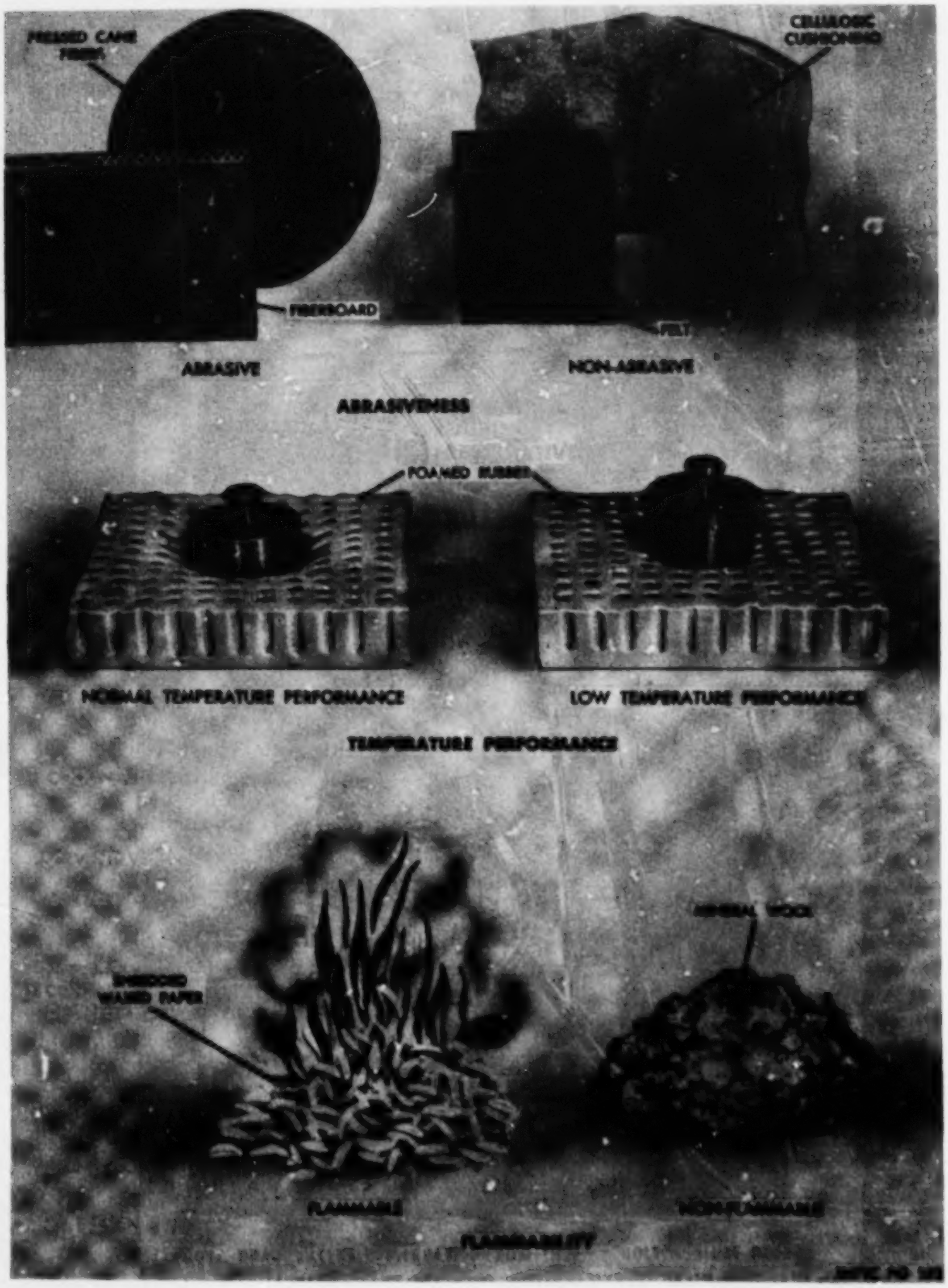

PRESSED CANE FIBERS
CELLULOSIC CUSHIONING
FIBERBOARD
FELT
ABRASIVE
NON-ABRASIVE
ABRASIVENESS
FOAMED RUBBER
NORMAL TEMPERATURE PERFORMANCE
LOW TEMPERATURE PERFORMANCE
TEMPERATURE PERFORMANCE
SHREDDED WAXED PAPER
MINERAL WOOL
FLAMMABLE
NON-FLAMMABLE
FLAMMABILITY

Figure 3-8. Characteristics of cushioning materials-abrasiveness, temperature performance, and flammability.

terials is undesirable when packing items with critical surfaces. When this cannot be avoided, the item must be shielded from such materials by a neutral wrap or liner. Cushioning materials with a high acidic or alkaline content must not be enclosed within waterproof or water-vaporproof barriers (fig 3-7).

(*f*) Fungus resistance of some materials is low and allows for the growth of mold, mildew, and other fungi. Many materials can be treated to inhibit such growth. However, such treated materials are often very corrosive to metal surfaces and must be isolated from them (fig 3-7).

(*g*) The abrasive characteristics of some materials are factors which must be considered when protecting precision surfaces such as the lenses of optical instruments. Some cushioning materials are soft-textured and generally can be placed in contact with easily marred surfaces. Coarse-textured materials should not be used on such surfaces (fig 3-8).

(*h*) Low temperature performance of certain cushioning materials makes them suitable for use in high altitude transport and in shipments to cold regions because they remain relatively soft and resilient (fig 3-8).

(*i*) Other characteristics which should not be neglected in choosing cushioning materials are fire resistance or flammability (fig 3-8), and the possibility of the material causing skin irritation to personnel who come in contact with it.

(3) *Destination of the item*. The destination of the item is a factor in cushioning. Many cushioning materials change their characteristics under extreme climatic conditions. Some materials become so rigid or brittle at extremely low temperatures as to make them useless as cushioning materials. In tropical climates, some materials soften and lose their cushioning qualities. In jungles or rainy locations, some materials will pick up excessive moisture which will result in the loss of resilience and will lead to growth of fungus and accelerated corrosion.

(4) *Means of transportation*. The means of transportation must not be overlooked. Hazards and handling situations vary greatly between air, motor, rail, and ship. *For example*, there may be considerable difference between the amount of handling that an item being transhipped from truck, to rail, to ship would get and one that is being shipped by air freight. Likewise, an item to be delivered by air drop would require different protection from one that would be delivered by truck.

e. Representative Cushioning Materials.

(1) *Bound fiber cushioning materials (PPP-C-1120).* These materials may consist of any suitable natural hair, vegetable fiber, or synthetic fiber bound with an elastic material. Horsehair, sisal, and cactus fibers sprayed with latex are common examples. The materials are furnished in four types and two classes. Class A is water-resistant, natural hair. Class B, common class, is not necessarily water-resistant. The four types are classified according to firmness, from soft (capable of supporting loads up to 0.01 PSI) to firm (capable of supporting loads up to 0.5 pound per square inch). They may be supplied as noncompressed flat sheets for general cushioning applications, or in molded forms shaped to fit the contours of the item. The materials have a high degree of resilience, low compression set, fair damping quality, and do not disintegrate easily. They are neutral and have a low water-soluble acidity so that their corrosive effects are slight. Moisture content and moisture absorption are both low; however, the materials may need to be treated for fungus resistance. Their performance is reduced at low temperature. They are intended to protect items against vibrational and impact shocks where resilient and water-resistant cushions are required.

(2) *Cellulosic cushioning material (PPP-C-843).* This material may be made of any kind of cellulosic matter which will result in a product meeting specification requirements. The cellulosic matter used may be cotton, bonded fibers, natural fibers, or creped wadding. The material is furnished in two types—Type I, water absorbent, and Type II, water-resistant. It is available in two classes—Class A, low tensile strength (filler material), and class B, high tensile strength (wrapping material). The material is required to be noncorrosive. However, even when it is water-resistant, water may be absorbed and retained within its pores. Cellulosic cushioning material is readily moldable and fairly resilient. Its compression set is high, its damping ability excellent, but dusting is great enough to require an excluding wrap around items susceptible to dust damage. Its performance in cold temperature is good. This material is intended for use in packing lightweight, fragile items; as a protection against abrasion; and Type I, specifically, for absorbing liquids from containers broken in transit.

(3) *Fibrous glass cushioning material (MIL-C-17435).* This material consists of glass fibers matted, bonded, or otherwise treated to meet specification requirements. The surface of Type II material is coated with an elastomeric material to prevent dusting. This material can be supplied in various classes of density ranging from a very soft material with a load range from 0.2 to 0.5 pound per square inch to a very firm material with a load range from 50 to 100 pounds per square inch. The resilience of the material is high, its compression set low, its damping fair, and its dusting slight, especially in the Type II material. It is highly flame-resistant and water-resistant. The material is neutral and will produce no corrosive effects. Moisture content and moisture absorbency qualities are low. The material is fungus-resistant and performs well at

low temperatures. Fibrous glass cushioning is intended for use in protecting packed or installed equipment against shock and vibration. A temporary skin irritation may occur as a result of handling the uncoated type (Type I). Minute fibers sticking to the skin are readily removed by ordinary washing. Suitable precautions and adequate ventilation should be used when there is any possibility of particles getting into the eyes or of accumulation of glass dust in the air.

(4) *Low density polypropylene foam cushioning material (PPP-C-1797).* This material, in rolls or flat sheets, is a low density, resilient, unicellular (closed cell) polypropylene foam material intended for use as a protective cushioned wrap for low density items. This foam, which may be laminated to such materials as paper, textiles, or plastics, maintains its usefullness throughout the temperature range of -65° to 160°F. It is also a good thermal insulator, non-dusting, noncorrosive and non-abrasive. For high density items it can be used for protection of surfaces from abrasion. Typical packaging applications include surface protection for optics, equipment with critical surfaces, electronic equipment and glassware.

(5) *Paper honeycomb cushioning material (MIL-H-9884).* This material consists of kraft fibers constructed into sheets of paper board that resemble honeycomb. This material is primarily used as an energy dissipating medium for landing shock to which air dropped objects are subjected. It may also be used for special packing requirements.

(6) *Wood excelsior in fabricated pads and bulk form (PPP-E-911).* Excelsior is made of shredded, straight-grained soft wood, free from mold, decay, and pitchy accumulations. It is furnished as bulk excelsior or as pads. The pads may be either waterproof or nonwaterproof. The bulk excelsior is obtainable in six grades, from superfine wood wool to coarse or ribbon excelsior. The pads are obtainable in twelve weights, from light to extra heavy. The material has a high compression set, medium resilience, and excellent damping qualities. Its moisture content and absorbency are high and the corrosive effects are considerable because of the wood acids present. It has poor fungus resistance, is highly flammable, and has poor low temperature performance. Its dusting characteristics are high and if the moisture content gets too low the material disintegrates into fine particles. It is abrasive and should not be used against finished surfaces which may be marred by scratching. Excelsior is best used for packaging in the waterproof pad form or as a cushioning layer between the walls of an inner and an outer container, with a waterproof liner to keep out excess moisture. The finer grades of excelsior are for cushioning the lighter, more fragile items, and the coarser grades are best adapted for cushioning rugged items.

(7) *Hair felt (C-F-202).* Hair felt consists of cleaned, washed, and sterilized cattle hair. It is finished in eight types based on the fabrication process. It is available in rolls, 48 inches in width, and in sheet form of various sizes. It has an average degree of resilience, low compression set, poor damping, and some amount of dusting. It will withstand repeated compression and abrasion without disintegrating. The felt must be free from acids. It will retain moisture and is subject to fungus attacks unless treated. It is used mainly as cushioning and padding of cradles for large articles. It should be glued in place and kept dry.

(8) *Solid and corrugated fiberboard (MIL-B-3106 and PPP-F-320).* Both solid and corrugated fiberboard are used in cushioning, but corrugated is more frequently used because it has greater cushioning value. The most common forms of fiberboard applications are die-cuts, open end cells, trays, pleated pads, and flat pads (fig 3-9). Generally, cells and trays should be held in shape with tape. Those surfaces of the cell or tray which are perpendicular to the contacting surface of the item are called bracing supports and are the load-bearing members. To utilize all of the strength of these bracing supports, they should bear directly on the item. Pleated pads have greater resistance to breakdown than open end cells because the load is spread over a large area rather than on bracing supports. Therefore, they should be used to cushion heavier loads (up to 2 pounds per square inch). Flat pads are used to block shallow projections, to level off projecting screw heads, and to separate items within a container. They can be slotted to form partitions, or may be die-cut or punched to fit articles of irregular shape. Application of fiberboard cells, trays, and pads is illustrated in figure 3-10.

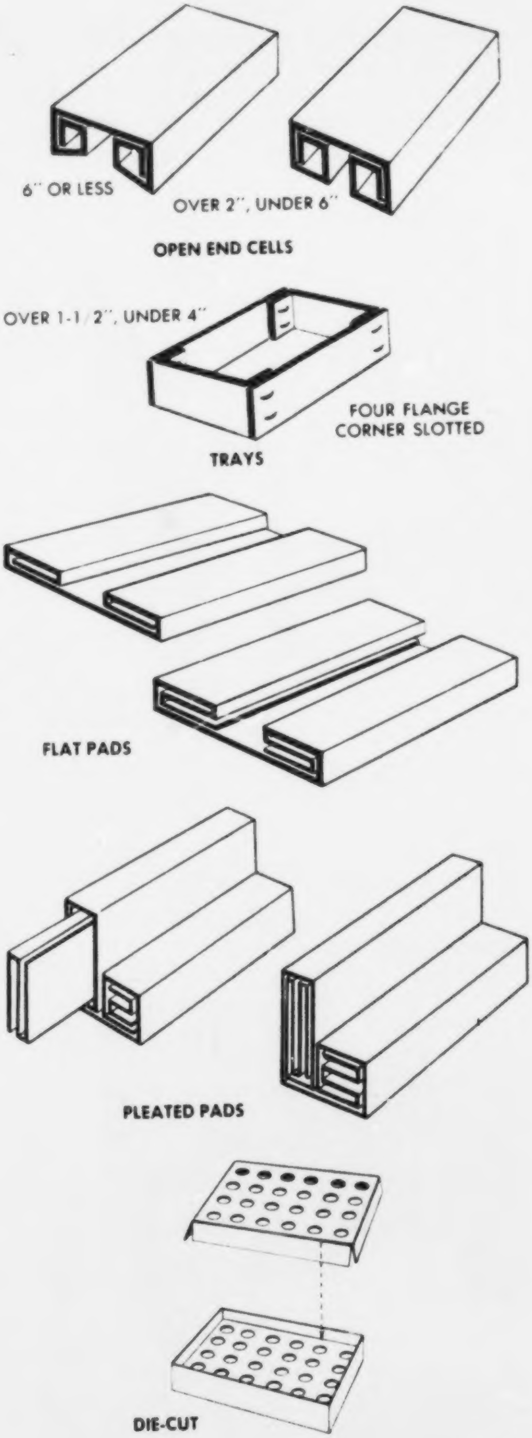
(9) *Solid fiberboard (MIL-F-26862).* This fiberboard is made from cane, wood or other vegetable fiber by a felting or molding process which incorporates a sizing agent to form uniform solid sheets, blocks, or special fabricated shapes. The board is made in two types—single-ply and laminated multiple-ply. The single ply is furnished in ½ inch and ¾ inch thickness. The material is available in a density of between 14 and 19 pounds per cubic foot. It has an average resilience, low compression set, low damping quality, and performs fair in cold weather. Its dusting qualities are low. The material is required to be neutral and low in water-soluble acid content. The moisture content and moisture retention qualities are low, and it has a low corrosive effect. It is also treated for moisture resistance.

(10) *Cushioning, wrapping paperboard (PPP-P-291).* This is a paperboard composed of a corrugated sheet or a solid molded pulp sheet firmly cemented to a backing flat sheet of unbleached sulfate fiber paper.

The paperboard is furnished in two types—light and heavy duty, and in two styles, Style 1—backing sheet, mandatory, and Style 2—backing sheet, optional. It is furnished in sheets or rolls, as desired. This material has high compression, low resilience, excellent damping, and some dusting. The moisture content and moisture absorption are high. The material is not neutral and hence has a high corrosion effect. Its performane in cold weather is poor, and it is neither fungus nor flame-resistant. Critical metal items must first be wrapped in a chemically neutral or greaseproof barrier.

(11) *Rigid or flexible polyurethane foam (MIL-P-26514) (fig 3-11).* This material consists of rigid and flexible foam, either prefoamed or a two-component liquid, foam-in-place system capable of producing polyurethane foam. The foam material is intended primarily for use as a cushioning material in packing applications. The polyurethane foams are furnished in two types: Type I—Prefoamed and Type II—Foamed-in-Place; Two classes: Class 1—Rigid and Class 2—Flexible. The type I urethane foam is supplied in rolls (class 2 only), sheets or molded shapes. Type II foam is supplied as a two-component liquid system consisting of a resin and a catalyst suitable for foaming-in-place. By proper combinations, reaction mixtures can be poured or pumped into various shaped cavities. Carbon dioxide is given off by the reactions, causing the rapidly stiffening resin to expand, completely filling the space. The material then sets rapidly to a lightweight, solid, porous structure that has excellent cushioning properties. Strong rigid foams, tough elastic foams, soft flexible foams, and spongy water-absorbent foams can be obtained by the choice of ingredients. These foams can be adjusted to give a high or low compressions set, excellent or poor damping, and high or low resilience. In other words, the material can be tailor made to meet the requirements of any type of cushioning required. The material is treated to be flame-and fungus-resistant. Foams stiffen in cold climate.

(12) *Cushioning material, plastic, open cell (PPP-C-1842).* This material is made from one or more sheets of plastic film formed into a network of uniform open cells. It is available in three types. Type I and II have hexagonal cells while type II has fluted cells. In addition, type III is an electrostatic free cushioning material. All three types are heat sealable on either side of the material, non-corrosive, and transparent. Type III is lightly tinted to indicate it has electrostatic free properties. This material can be used either as cushioning within a transparent bag or it may be used to fabricate bags or pouches.



JMPTC 756

Figure 3-9. Examples of fiberboard die-cuts, open end cells, trays, and pads.

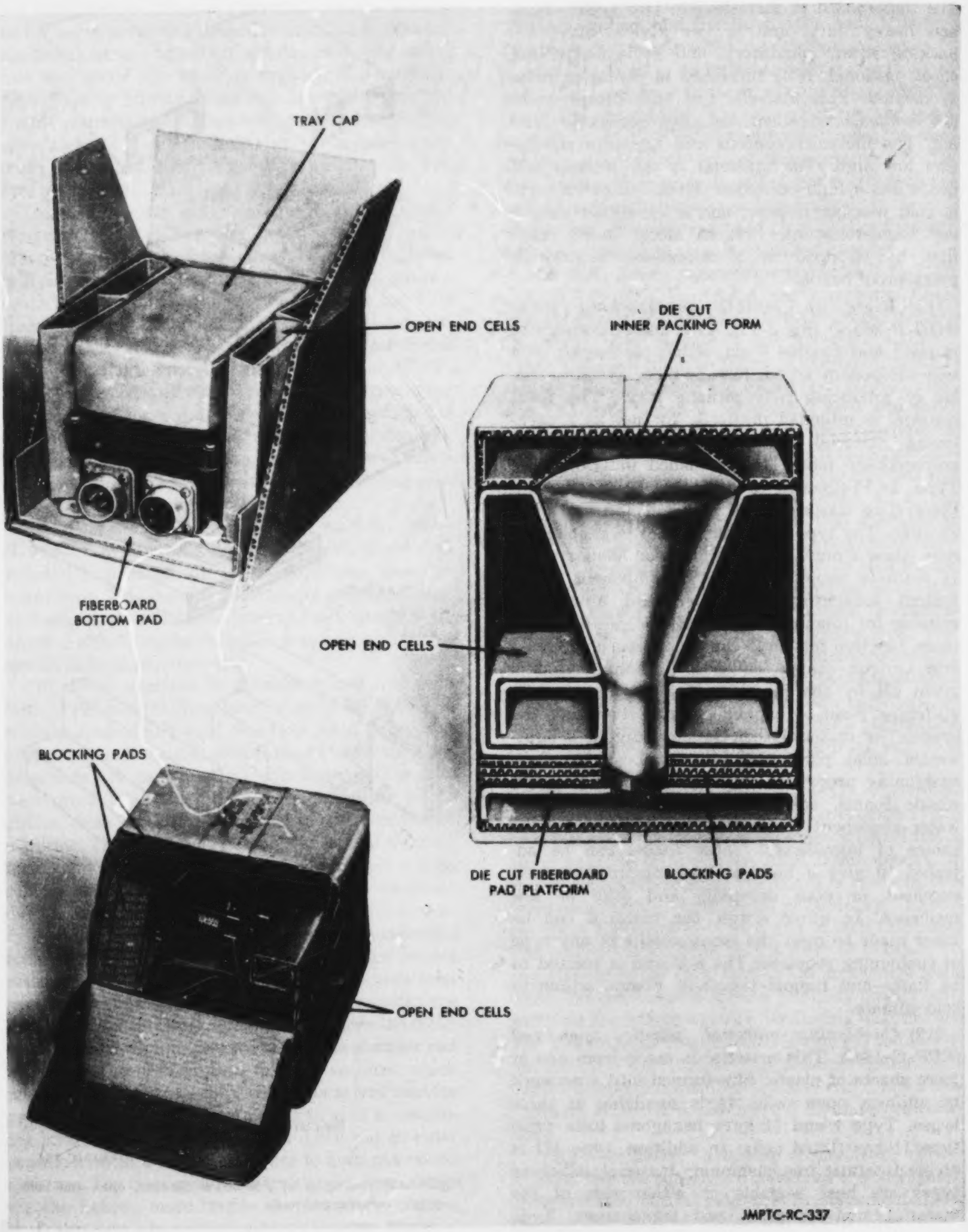

TRAY CAP
OPEN END CELLS
FIBERBOARD BOTTOM PAD
DIE CUT INNER PACKING FORM
OPEN END CELLS
BLOCKING PADS
DIE CUT FIBERBOARD PAD PLATFORM
BLOCKING PADS
OPEN END CELLS
JMPTC-RC-337

Figure 3-10. Application of fiberboard die-cuts, open end cells, trays, and pads.

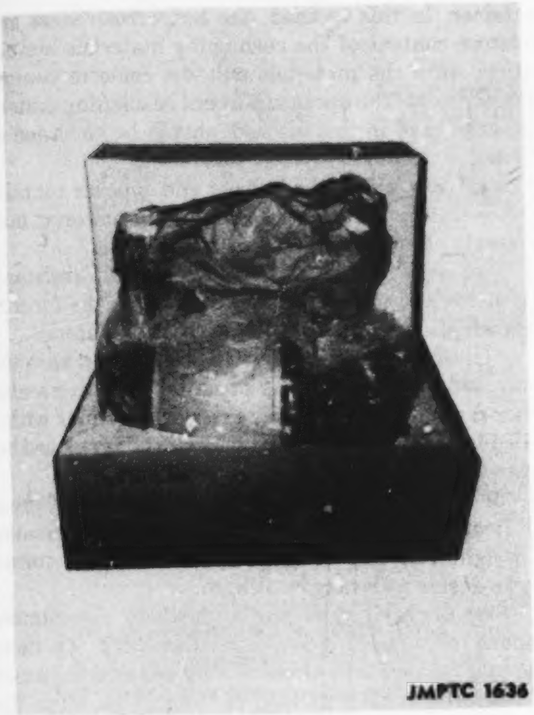


Figure 3-11. Polyurethane foam.

tent and absorbency, and poor to average low temperature performance.

(13) *Resilient, expanded, polystyrene cushioning material (PPP-C-850).* This is a resilient cushioning material of expanded polymer of copolymers of styrene for use in cushioning and packaging applications. It is available in two types: Type I—sheet form, classed as soft, medium, firm, and extra firm; Type II—roll form, with the same classes as Type I. The material is nonabrasive and fungus- and mold-resistant. It is used as a cushioning material within packs to protect items from damage due to shock, vibration, abrasion, and concentrated forces during handling and shipment. It is especially suited to packing problems where a high degree of energy absorption is required in a minimum space and with a minimum weight of cushioning; to packing problems in which the cushioning material should also provide temperature insulation; and to packing problems in which the cushioning material must perform at extremely low temperatures. Resilient polystyrene cushioning material may be furnished in special converted forms, sizes, and shapes, such as with paper backing, paperboard backing, cloth backing, pressure-sensitive adhesive surface, die-cut holes or in the form of corner pads of special shapes.

CAUTION

Expandable polystyrene cushioning materials contain gaseous hydrocarbons which are explosive. Seven days exposure to the atmosphere after expanding is required to dissipate the hydrocarbons to that the products are no longer dangerous.

(14) *Plastic film, flexible, cellular (PPP-C-795).* This material is constructed of two composite sheets of plastic film, one face has uniformly distributed closed cells (bubbles) and a flat surface on the other face. It is available in two classes: Class 1 transparent and Class 2 opaque. The Class 1 material is especially suitable for use as cushioning inserts within transparent bags and envelopes to permit inspection of contents without opening the pack, evidence of physical damage, identification surface condition, and condition of humidity indicators. The flexibility of the material permits it to be used as pads, bags, as a wrap, as dunnage, or as a filler. The material is heat sealable.

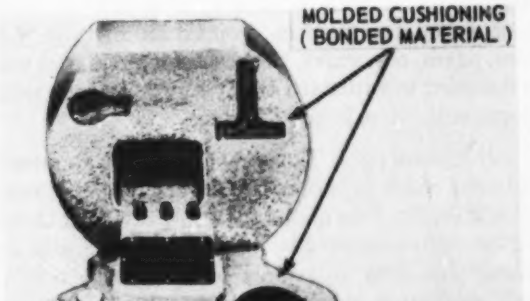


Figure 3-12. Methods of cushioning—floated item.

(f) Methods of Cushioning. Cushioning is generally accomplished by one of the following methods:

(1) *Floated item.* The item is floated in cushioning material and placed within a unit container (fig 3-12). This is perhaps the method most commonly used for cushioning small, lightweight, fragile items against shock, vibration, and abrasion. It is in this case that the requirements of MIL-P-116 concerning dryness and noncorrosiveness of cushioning materials are most important since both the item and the cushioning material will be inclosed in the unit container. Cushioning materials in direct contact with metal surfaces shall meet the requirements of MIL-P-116 (para 3-1*e* and *c* above). The accepted practice today, when the requirements of MIL-P-116 have been met, is to make the cushioning the first wrap. Greaseproof barriers are required if the item is preserved. Cushioning materials must be secured about the item. Loose cushioning may result in either the displacement of the material when the pack is subjected to shock, its disintegration under repeated vibration, or the production of dust or loose particles which will be entrapped within the pack. Since a container may be dropped on any one of its faces, edges, or corners, the cushioning material must be designed to withstand the full impact of the entire weight of the item in any direction.

(2) *Floated pack.* The item is packed in an interior container which in turn is floated in cushioning material (fig 3-13). This method is generally used in connection with semi-fragile items of medium size and weight. The item is initially packed (which may include cushioning or blocking) in an interior container, then floated in cushioning, and placed into an exterior container. In this method, the noncorrosiveness and moisture content of the cushioning materials are not critical since the materials will not come in contact with the item. The use of absorbent cushioning materials, when used in this method, should be governed as follows:

(*a*) When both the interior and exterior containers are water-resistant, the cushioning material may be simply placed between the two containers.

(*b*) When either container is nonwater-resistant, the cushioning material must be placed in the form of pads wrapped in a water-resistant barrier material.

(*c*) Another alternative for the second case ((*b*) above) is to provide the interior container with a sealed water-resistant wrap and the exterior container with a sealed liner. The cushioning material is then placed between the two barriers.

(3) *Corner pads and side pads.* In cases where a full floated item or pack is not justified either because of weight and size or fragility of the item, corner blocks or side pads may be utilized.

(*a*) Corner blocks are used where a minimum amount of material is required to cushion the item. The total surface area of cushioning material for a side is determined, then divided by four. This gives the amount of material for each corner. This is done in turn for all six surfaces (fig 3-14). Corner pads are also used where the only requirement of the cushioning is separation of the item from the container.

(*b*) When the amount of the cushioning material required is too great for proper utilization of corner pads, the use of side pads is indicated. The amount of material per side must be of sufficient quantity as to preclude buckling.

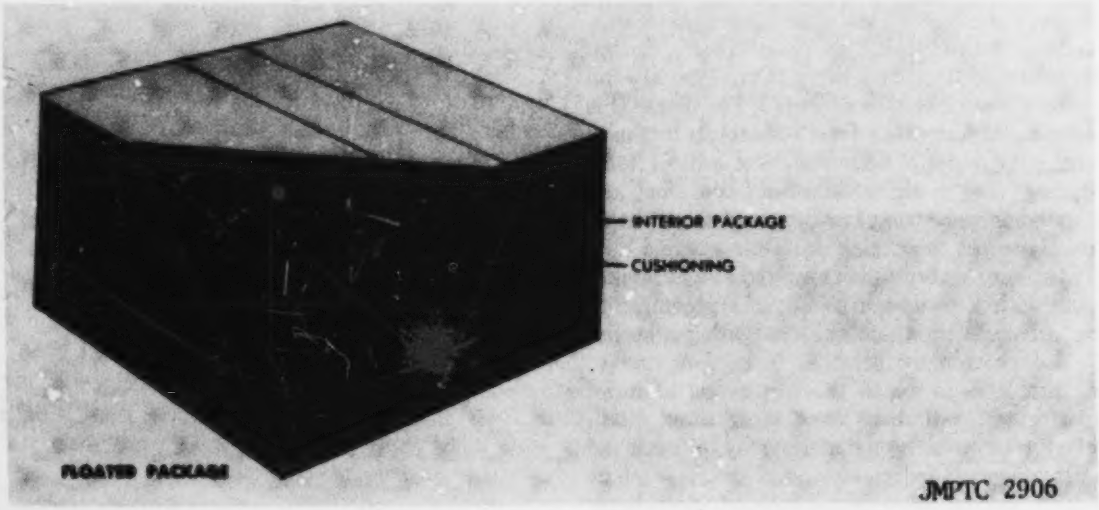
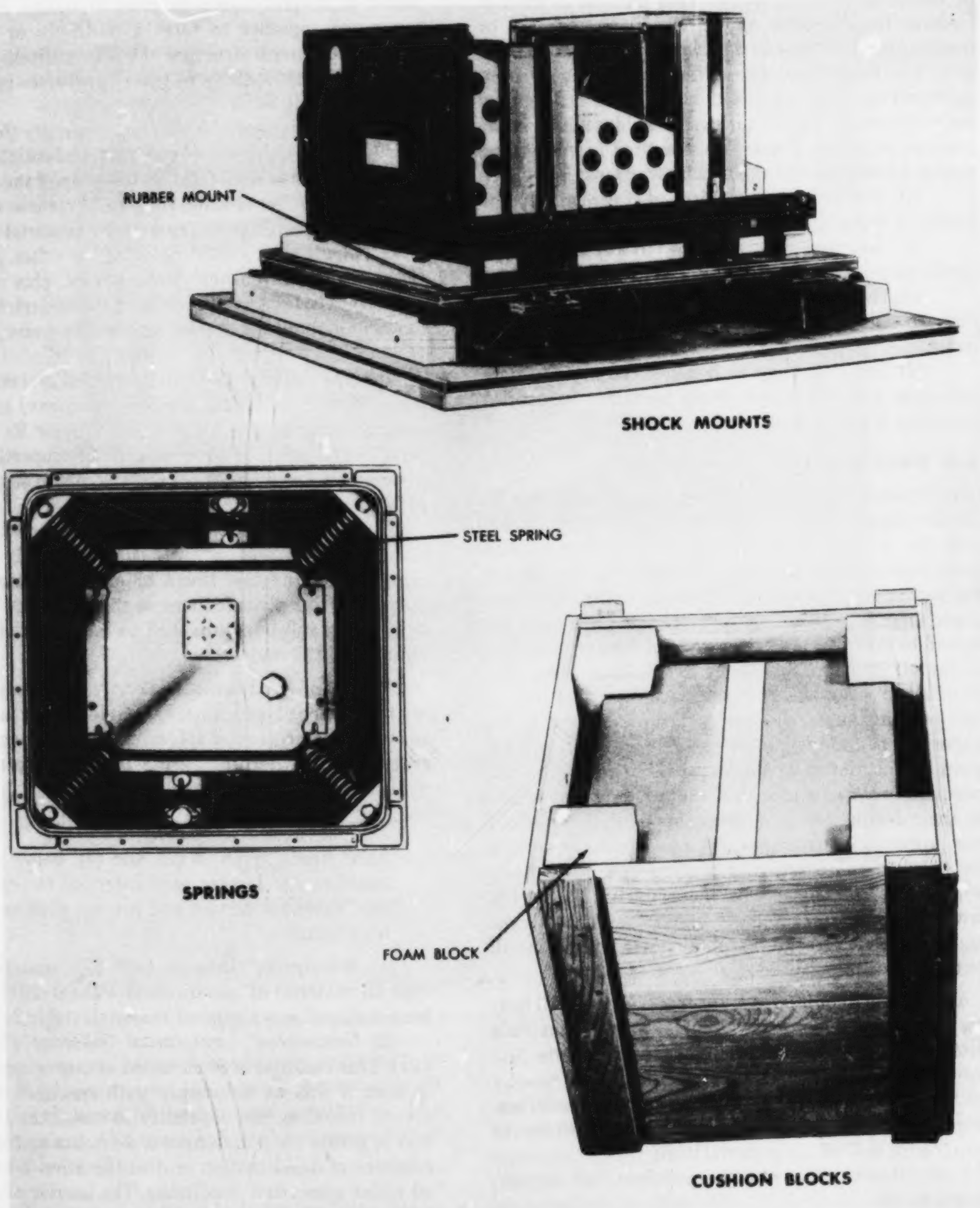


Figure 3-13. Methods of cushioning—floated pack.


RUBBER MOUNT
STEEL SPRING
FOAM BLOCK

SHOCK MOUNTS

SPRINGS

CUSHION BLOCKS

JMPIC PG 195

Figure 3-14. Methods of cushioning—shock isolators.

(4) *Shock mounts.* The item is cushioned by means of shock mounts (fig 3-14). This method is used to cushion fragile items and sensitive instruments or mechanisms that can be damaged by shock and vibration. The weight and size of the item may vary from light and small to heavy and large. The shock mounts may consist of metal springs with damping, shear mounts, or corner blocks. This method of cushioning may be accomplished in four main ways—

(*a*) The item may be suspended directly by the means of shock mounts.

(*b*) The item may be blocked in a cradle and the cradle suspended by means of shock mounts.

(*c*) The item may be boxed in a unit container and the unit container suspended by means of shock mounts.

(*d*) The item may be boxed in an intermediate container and the intermediate container suspended by means of shock mounts.

3-6 Heat Sealing

a. Importance of Heat Sealing. Since World War II, the development of flexible heat sealable barrier materials for military purposes has proceeded at a rapid pace. Scores of barrier materials have been produced for packaging everything from radio tubes to jet airplane engines. These barrier materials have been designed to insure long term storage of military supplies under all climatic conditions. They have been constructed to keep preservative oils and greases in contact with metal surfaces and to keep water and water vapor out of the interior of packs. Regardless of how good the barrier material may be, if the pack is not adequately closed and sealed, the contents may arrive at their destination in an unusable condition. One of the problems confronting personnel engaged in military packaging operation is to obtain good heat seals when using heat sealable barrier materials. In the following paragraphs, the basic requirements, methods, and equipment necessary to obtain good heat seals will be discussed.

b. Military Requirements for Heat Sealing. All heat seals performed on heat sealable barrier materials must meet the following three basic requirements:

(1) The heat seal must not leak.

(2) The heat seal must give the same degree of waterproofness, vaporproofness, or greaseproofness as required of the barrier material itself.

(3) The seal must pass the test described in paragraph 3-40.

c. Construction of Heat Sealable Barrier Materials. To understand the factors essential to proper heat sealing and the equipment needed to produce acceptable heat seals, a general knowledge of the construction of the materials involved is helpful. Most of the heat sealable barrier materials used by the military are composed of several layers or plies of unlike materials laminated together to form a multi-ply or built-up sheet. The general structure of such a built-up sheet or barrier is a heat sealable face, an impervious ply, and a backing ply (fig 3-15).

(1) *The heat sealable face may be a ply (film) or a coating.* This is a thermoplastic material which has the ability to become semi-fluid and flow upon the application of heat. After cooling, the plastic returns to a normal, solid, flexible state. This facing material is made from polyethylene, vinyl chloride, or other plastics. Besides providing a heat sealable face, this material also serves to fill tiny pine holes in the underlying plies to aid in making the barrier resistant to water, grease, or vapor.

(2) *The impervious ply is composed of a metal foil (aluminum) or a plastic film (polyethylene, cellulose-acetate, etc.).* It gives the whole barrier its greaseproof, waterproof, or watervaporproof properties. This ply may also serve as a heat sealable ply in some types of barrier materials.

(3) *The backing ply is usually a cotton cloth (scrim), other fabric, or kraft paper.* This ply may be reinforced with glass fibers or other materials. The purpose of this ply is to increase the resistance to abrasion, wear, and puncture, and to improve the tensile strength of the whole sheet.

d. Types of Heat Sealable Barrier Materials. There are three major types of heat sealable barrier materials based on the protection afforded by the material. The materials are waterproof, greaseproof-waterproof, and watervaporproof respectively.

NOTE

Time limits given in (2), and (3), below are based on accelerated tests intended to represent extended service and are not shelf/service life limits.

(1) *Waterproof material.* L-P-378, material, and type III material of specification MIL-B-22191 have been designed as waterproof materials (table 3-9).

(2) *Greaseproof, waterproof material (MIL-B-121).* This material is constructed of one or more plies in such a way as to comply with specified requirements, including the capability to resist the *penetration of grease* for a minimum of *24 hours* and show no evidence of delamination or disintegration when tested under prescribed conditions. The barrier must also be capable of resisting the *penetration of water* for a minimum of *24 hours* when tested as required (table 3-9).

(3) *Water-vaporproof material (MIL-B-131).* This material is constructed of one or more plies in such a way as to comply with performance requirements, in-

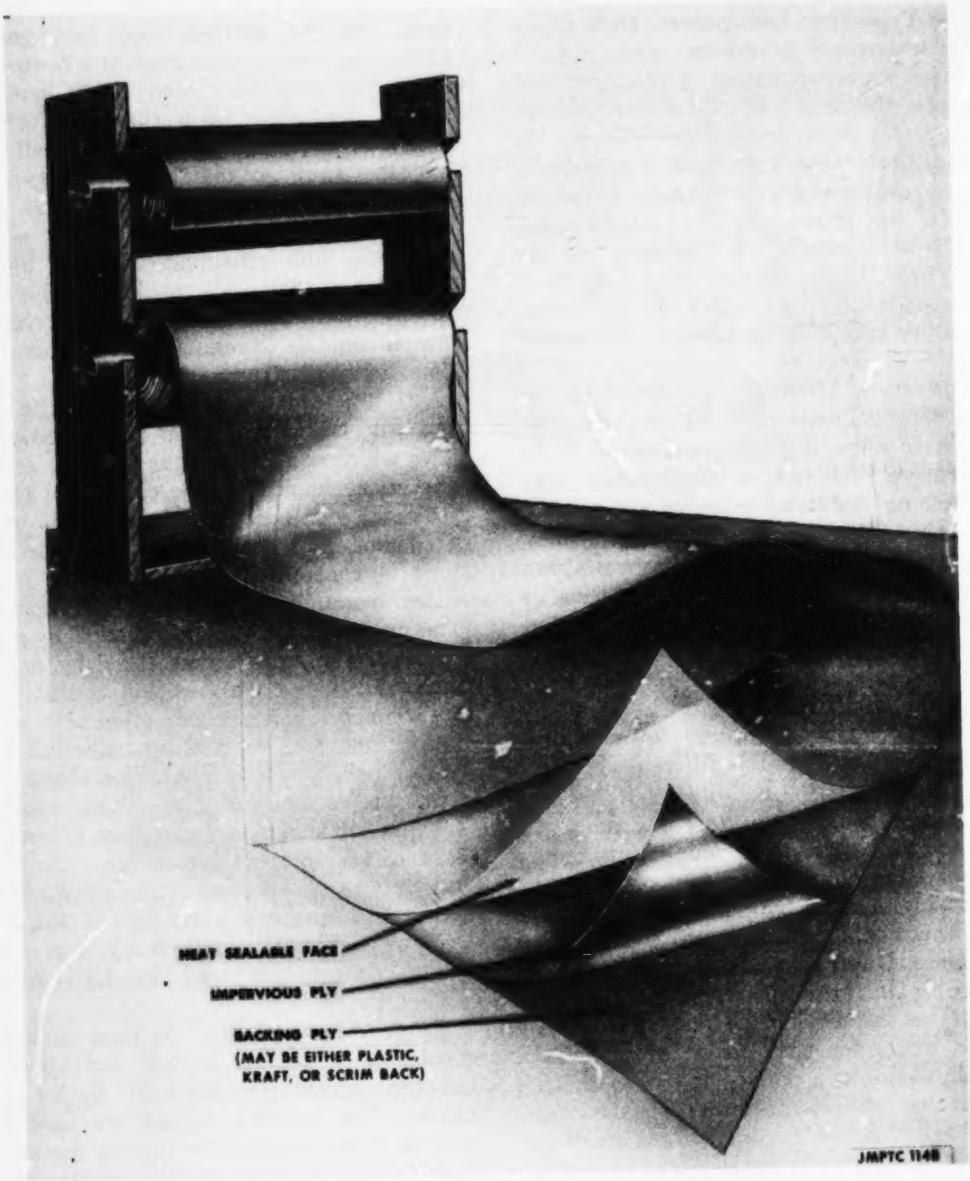


Figure 3-15. General structure of heat sealable barrier materials.

cluding a water vapor transmission rate not to exceed 0.05 gram per 100 square inches per 24 hours as determined under test conditions. The material must also pass oil- and water-resistance tests (tables 3-9).

(4) *Transparent, flexible, heat sealable material (MIL-B-22191).* MIL-B-22191 material is an unsupported, transparent film and will provide protection required by all basic methods of preservation depending upon the type of material used (table 3-9). As received from the manufacturer, this film, in addition to other markings, will show a notation "seal other side." This will appear on the fluorocarbon side, for Type I, since one face is polyethylene and the other fluorocarbon, and only the polyethylene face is heat sealable.

(5) *Electrostatic-free, flexible, heat sealable material (MIL-B-81705).* MIL-B-81705 material is intended for use with electrostatic and/or electro-magnetic-sensitive equipment or components. These materials are especially formulated to prevent the build-up or retention of electrostatic forces thus protecting the item from static electricity and electrostatic discharge damage.

This barrier is available in two types - Type I is opaque while Type II is transparent. Both types also provide waterproof protection, while Type I also provides watervaporproof protection and electromagnetic shielding (radar field attenuation).

e. *Factors Essential to Proper Heat Sealing.* To produce heat seals that can meet the requirements of *b* above, there are three essential factors that must be considered and fully understood. These are the temperature, the pressure, and the dwell time. These factors are not independent but fully interdependent of each other. If one factor varies, the other two must be adjusted for proper correlation.

(1) *Temperature.* Enough heat must be applied to the thermoplastic material on the sheets to be bonded to allow it to soften and reach its flow temperature. Too low a temperature may result in either no seal being made or a weak seal (adhesive tack). Too high a temperature may cause delamination or separation of the backing ply from the other plies and/or decomposition of the thermoplastic. Barrier materials, generally, must be capable of being heat sealed at a temperature not to exceed 525° F. Manufacturers of heat sealable barrier materials are required to supply recommended temperatures for effective sealing of their materials on the different types of equipment authorized by the Military (*f* below).

(2) *Dwell time (length of time the material remains in the heating zone).* Enough time must be permitted to raise the temperature of the heat sealable face to its flow temperature and allow the molten thermoplastic surfaces to form one continuous mass. Dwell time and temperature are interdependent. The lower the temperature, the greater must be the dwell time and vice versa, provided the limits for each factor are not exceeded. As an example, a particular barrier material, when sealed at a temperature of 450° F., requires a dwell time of 2½ seconds to produce heat seals with maximum strength. The same material, sealed at 400°F., requires a dwell time of 3 seconds to produce seals with the same strength characteristics. With the exception of special equipment, no dwell time below ½ seconds will produce a good heat seal regardless of the temperature used.

(3) *Pressure.* The purpose of using pressure is to bring the surfaces to be sealed into intimate and continuous contact, thereby aiding in the heat flow through the backing material (e. g., scrim or kraft) to the thermoplastic surfaces. Excessive pressure tends to force out the molten thermoplastic material and results in defective seals. Pressure should be maintained at 40 to 80 P.S.I.

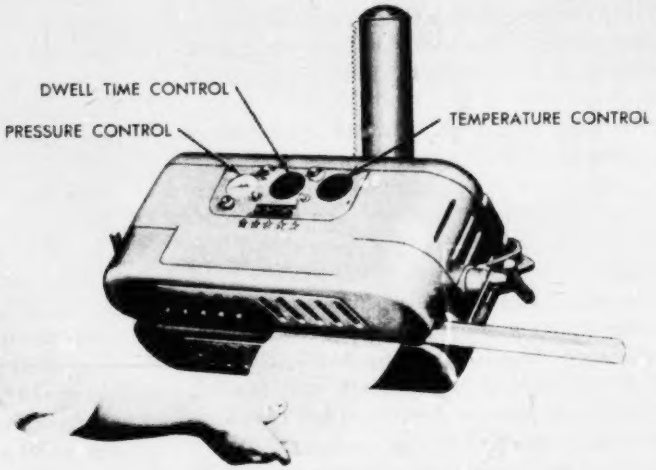
f. Heat Sealing Equipment. Heat sealing equipment can be divided into two general classifications: *unit* or *jaw type* and *continuous type.* Each type may have many variations or attachments, depending upon the manufacturer; however, the basic operation is essentially the same within each classification. Specification MIL-S-4461 covers both unit and continuous type heat sealers intended for heat sealing thermoplastic film (unsupported) and barrier (supported) materials. All machines covered by this specification must have adjustable, directly calibrated controls to regulate the temperature, dwell time, and pressure.

(1) *The unit or jaw type sealer (fig 3-16).* This type of sealer comprises two opposed, parallel jaws which can be brought together either manually or mechanically. One or both of the jaws are provided with heating elements. The temperature is controlled by means of a thermostat. The dwell time is controlled by the duration of pressure, either manually or by automatic timing devices. The pressure is usually controlled by a spring or by a pressure cylinder actuated by pneumatic or hydraulic power. The jaws of a unit type sealer are sometimes covered or coated with an antistick facing material to prevent adhesion of plastic films to the hot surfaces. Some sealers are made with one or more resilient jaws which help to smooth out irregular thicknesses of material such as wrinkles, splices, gussets, etc.

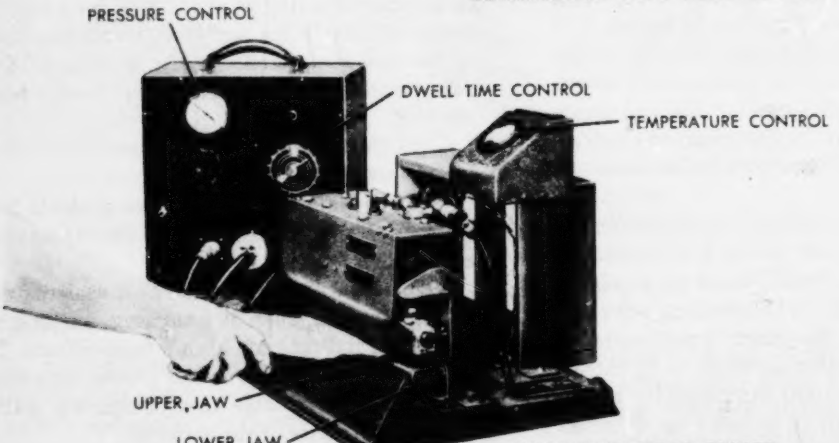
(2) *The continuous type sealers (fig 3-16).* There are two basic variations of the continuous type sealer known as rotary and band type sealers, which are used for high volume heat sealing operations.

(a) Rotary sealers in their simplest form consist of a pair of driven and heated rollers between which the material to be sealed is passed. The rotating wheels are used to apply heat and pressure to the barrier material. Dwell time is controlled by varying the rate of speed at which the material passes through the rollers. Rotary sealers are usually equipped with a chain or belt type intake to feed the material into the sealer and a discharge unit to guide the material out of the sealer after it had been sealed. Some sealers employ "preheaters" to precondition the temperature of the thermoplastic prior to sealing.

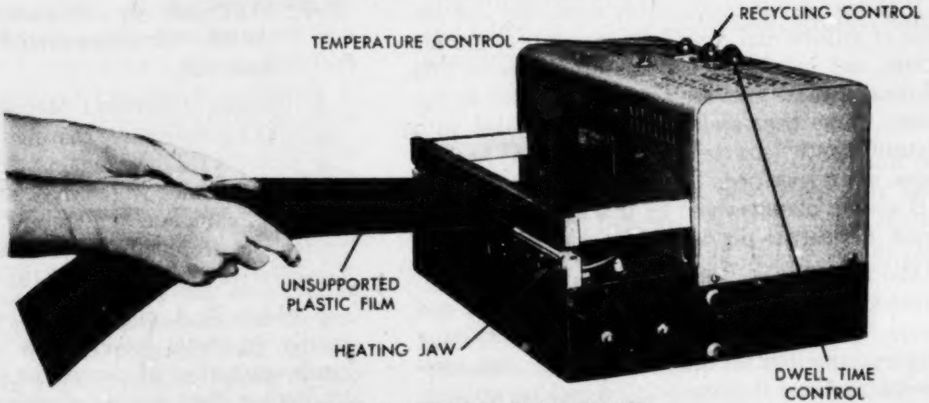
(b) Band type sealers make use of two thin endless metal belts to carry the material through the heating zone (and sometimes a cooling zone) while applying pressure and heat continuously. The band type sealer may look like a rotary sealer but operates on a different principle. Heat is transferred from the heating jaws through the metal bands to the barrier material


DWELL TIME CONTROL
PRESSURE CONTROL
TEMPERATURE CONTROL

CONTINUOUS TYPE HEAT SEALER


PRESSURE CONTROL
DWELL TIME CONTROL
TEMPERATURE CONTROL
UPPER, JAW
LOWER JAW

UNIT TYPE HEAT SEALER


RECYCLING CONTROL
TEMPERATURE CONTROL
UNSUPPORTED PLASTIC FILM
HEATING JAW
DWELL TIME CONTROL

THERMO IMPULSE HEAT SEALER

JMPTC-RC-314A

Figure 3-16. Heat sealing equipment.

The temperature is thermostatically controlled. The dwell time is controlled by varying the speed of the bands through the heating zone. The pressure is usually applied by pressure rollers, although a small amount of pressure is applied to the bands by the heating jaws. The roller pressure is controlled by mechanical or hydraulic power, or both.

(3) *Other types of sealers.* There are other types of heat sealing machines which are used primarily for the sealing of unsupported films (para 3-4*d*). A brief description of two or these follows:

(*a*) *Electronic type.* This type uses a high frequency current to generate heat in the surface to be sealed as the material passes between two electrodes. The electrodes remain at room temperature.

(*b*) *Electrical impulse type (fig 3-16).* This machine which is covered by military specification MIL-S-22783 looks like a conventional jaw type sealer and operates mechanically the same way, except that an electrical resistance wire is mounted on one of the sealing jaws. The electrical resistance wire, when brought in contact with the material, is heated in a fraction of a second by a heavy current flow and melts and fuses the thermoplastic. The jaws remain closed after the flow of current, thus cooling the seal under pressure. Polyethylene, vinyl, polystyrene and polyester are some of the films commonly sealed with electrical impulse type sealers.

(*c*) *Manually operated electric sealing irons and plates.* These sealing irons and plates are covered by military specification MIL-S-43336 and are available in two types. Type I has a 125 to 150 watt capacity and resembles a soldering iron. The heating surface is 3⅞ inches long by 1⅜ inches wide; tapering to 1⅛ inches wide. Type II has a 900 to 1000 watt capacity and is rectangular in configuration, 12 inches long, 9 inches wide, and 3 inches thick. The type I sealing iron and type II plates are thermostatically controlled and are capable of infinite and rapid adjustment between the minimum and maximum temperature. Pressure and dwell time of these heat sealers are controlled by the operator. These heat sealers may be provided with polytetra-fluorethylene (teflon) covers for the heating surfaces, when specified. The type I sealing iron and type II sealing plate covered by this specification are intended for heat sealing cellophane and polymer film material.

g. Determination of Temperature, Dwell Time, and Pressure. There are several methods for determining the approximate temperature, dwell time, and pressure to be used as a starting point in making satisfactory heat seals. Two of these methods are as follows:

(1) *The manufacturer's recommendations.* Manufacturers' recommendations are furnished with each roll of barrier material; these include the recommended temperature, dwell time, and pressure to be used on rotary, band, and jaw type equipment. These recommendations will usually give a good indication as to the settings to be used in the initial attempt to heat seal. The recommended values should be used cautiously because some thermoplastics and adhesives change characteristics upon aging; recommended values for one type of sealing machine do not apply to all machines of the same type; and machines of the same make may vary in temperature, dwell time, and pressure at identical settings.

(2) *Determination by trial and adjustment.* If satisfactory heat seals are not obtained by following the manufacturers' recommendations, or if the recommendations are not available, the temperature, dwell time, and pressure should be determined by the following trial and adjustment method. Set the heat sealing machine controls for dwell time at 2 seconds and pressure at 60 p.s.i. and maintain constant. Heat seal specimens of barrier material at 25° to 50° increments of temperature starting at about 250°F for kraft-backed sheets and 300°F for scrimbacked sheets. After cooling the sealed specimens to room temperature, pull each specimen slowly apart by hand and observe the following:

(*a*) Degree of difficulty in separating the sheets of barrier material.

(*b*) Delamination of the heat sealable face from the other plies of the barrier, and the extent of delamination.

(*c*) Color changes on the heat sealed area of the backing material, such as scorching, burning or charring, which indicate too high a temperature. The correct temperature to use is the lowest temperature at which the heat sealable face completely pulls away from the other plies of the material.

3-7. Method I, Preservative Coating (With Greaseproof Wrap as Required)

a. Concept of Method I. Method I is accomplished by applying a preservative coating to the item. This coating protects the item against free water, salt spray, gases, and fumes which may be encountered during handling, shipping, and storage. The entire chemical protection afforded to the item is through the contact preservative (fig 3-17 and 3-18).

b. When To Apply Method I. Method I is used primarily on metal items whose characteristics allow ready application of a corrosion preventive compound by dipping, flow coating, slushing, spraying, flushing, brushing, or fogging. Items preserved by method I must be such that depreservation by means of solvents, vapor degreasers, or alkali metal-cleaning compounds will not damage the item nor impair its opera-

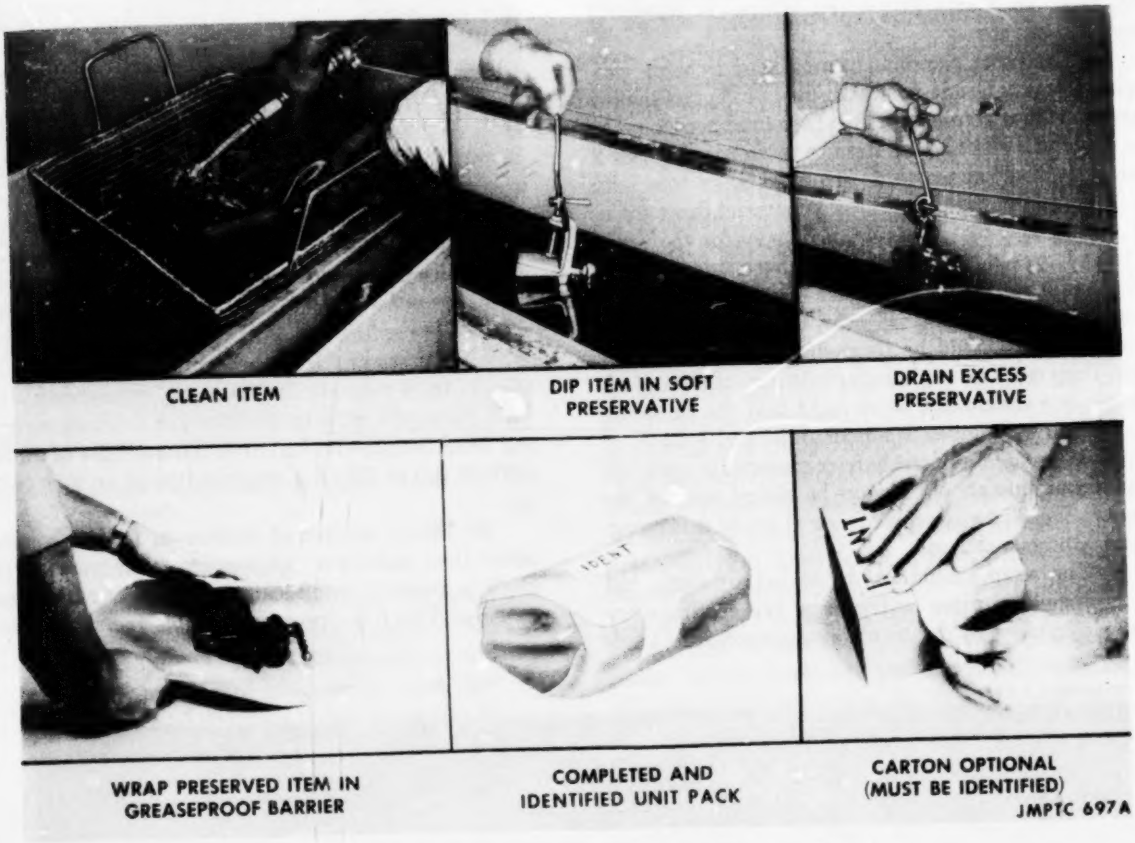

CLEAN ITEM
DIP ITEM IN SOFT PRESERVATIVE
DRAIN EXCESS PRESERVATIVE
IDENT
IDENT
WRAP PRESERVED ITEM IN GREASEPROOF BARRIER
COMPLETED AND IDENTIFIED UNIT PACK
CARTON OPTIONAL (MUST BE IDENTIFIED)
JMPTC 697A

Figure 3-17. Application of method I using a soft film preservative.

tion. The determining factor is the selection of this method is whether or not the nature and design of the items permit application and removal, when necessary, of the compound without damage to the items. Method I, with a hard-drying, thin-film preservative, P-1 or P-19 (fig 3-18), is widely used for preserving metal parts. Method I, with a hard-drying, thin-film preservative is particularly adapted to items whose function or operation is not impaired by the presence of a hard-surface coating. Hammers, chisels, mounting brackets, and turnbuckles are some of the items which do not require depreservation before being placed in operation. The protection of an item preserved by method I depends upon a clean and moisture-free surface, and a well applied and continuous preservation film. After the cleaning operations, items must be protected, particularly, against moisture and deposits from fingerprints. To avoid corrosion, rubber or canvas gloves shall be worn whenever items are handled from the initial cleaning stages until the preservative coating has set or dried. After cleaning and drying, the selected preservative is applied to the item. Dipping is the preferred method, since total immersion produces the most uniform and continuous coating. Spraying, slushing, brushing, or flow coating may be used if the size, shape, composition, or design of the item hampers dipping. Straight mineral oils are not satisfactory as preservatives. However, compounds designed specifically for preventing corrosion, and consisting of mineral oils with surface active and corrosion inhibiting additives, are effective (para 2-9).

c. *Materials Needed for Method I.*

(1) *Contact preservative compounds and oils (table 2-2).* The compounds most commonly used are P-1, P-2, P-3, P-6, and P-19. All other compounds have been used successfully for the special applications listed in the next to the last column of table 2-2.

(2) *Barrier for protective wrapping.* Greaseproof, acid free, noncorrosive barrier material is wrapped on preserved items to prevent loss of the compound or injury to the protective film. This barrier material will conform to Specification QQ-A-1876, Grade A of MIL-B-121, or Type II of MIL-B-22191. Parts which are attached to a larger item, or which for other reasons cannot be individually inclosed, will be wrapped to protect the coated surfaces.

d. How To Apply Protective Wraps to Method I Preservation.

(1) The most common barrier used to wrap preserved items is Grade A of MIL-B-121. Type I (heavy duty) and Type II (medium duty) are used according to the size and weight of the item to be wrapped. Class 2 material (nonheat-sealable, stretchable) is specially suitable for this purpose. Class 1 material (heat sealable, nonstretchable), designed primarily for the fabrication of greaseproof, waterproof bags, may also be used as a protective wrap in case of nonavailability of class 2 stock.

(2) Wraps should be formed to the shape of the item. They must be made to include a minimum of air volume, but should not be so tight that the preservative coating is damaged (fig 3-19, 3-20 and 3-21).

(3) When a laminated barrier material is used, the greaseproof side should always be placed against the preservative. The greaseproof side of grade A is recognized by its smoothness.

(4) The wrap should not be sealed air tight, but should be held in place by taping or tying. Wraps are best held in place by means of pressure-sensitive tape. Wraps are left unsealed so that water will not be trapped against the preservative, and so that condensed water within the wrap will evaporate.

(5) All wraps shall be marked or labeled to clearly identify the wrapped items.

(6) Identification is not required on greaseproof wraps of items immediately placed in unit containers where identification is on the containers (table 3-11 and para 3-46).

(7) Items treated with P-1 or P-19 do not require a greaseproof wrap, but in all cases these preservatives must be dry before subsequent packing.

(8) Aluminum foil conforming to Specification QQ-A-1876 may also be used as a greaseproof wrap. This material comes in 14 different thicknesses ranging from twenty-five hundred-thousandths of an inch (.00025 in.) to fifty ten-thousandths of an inch (.0050 in.).

(9) Direct contact of aluminum foil with metals other than cadmium, magnesium, aluminum, or zinc shall be avoided in applications which may be exposed to water. This is to prevent a possible galvanic action.

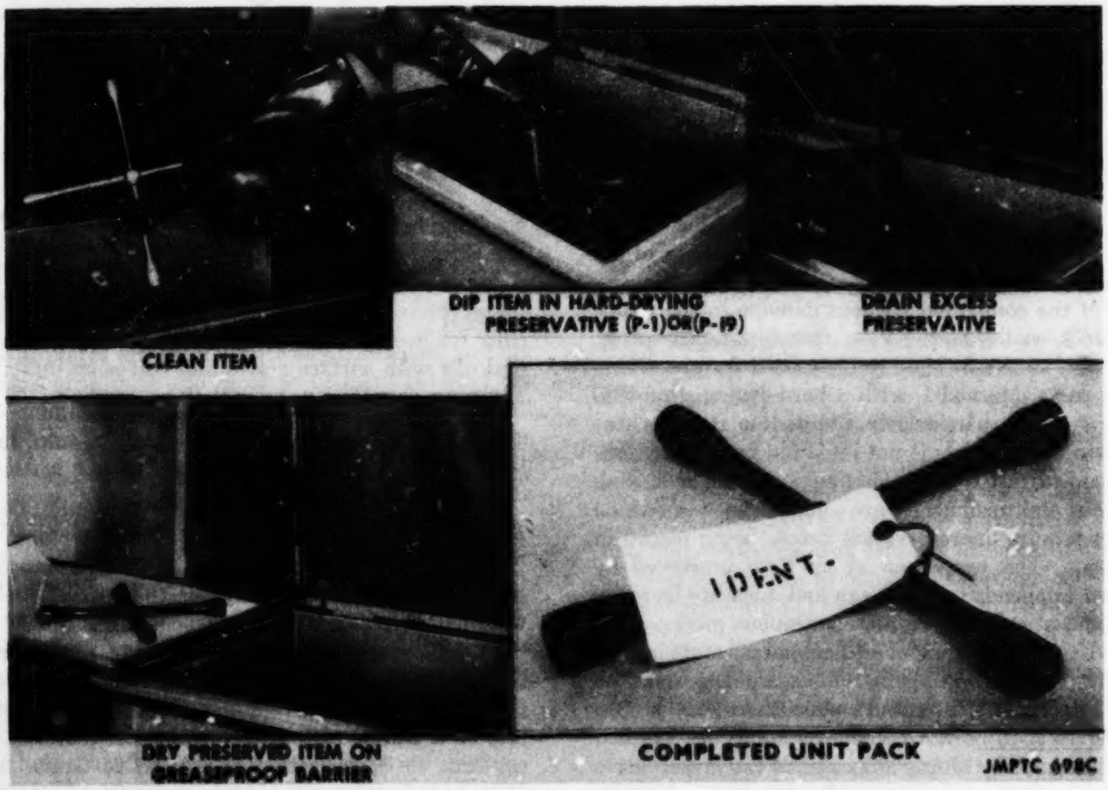

CLEAN ITEM
DIP ITEM IN HARD-DRYING PRESERVATIVE (P-1)OR(P-19)
DRAIN EXCESS PRESERVATIVE
DRY PRESERVED ITEM ON GREASEPROOF BARRIER
IDENT.
COMPLETED UNIT PACK
JMPTC 698C

Figure 3-18. Application of method I using a hard-drying preservative.

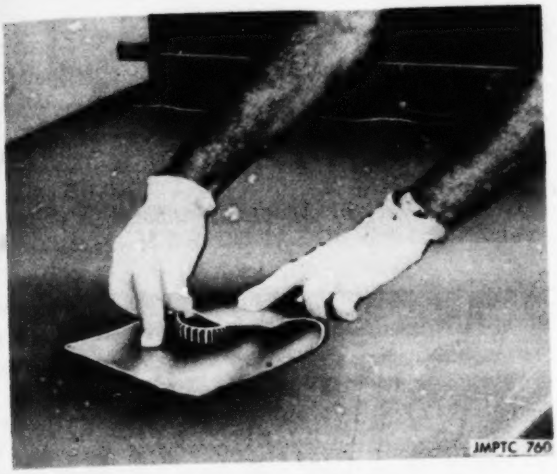


Figure 3-19. Method I wraps—use large enough wrap to cover item completely.

NOTE

The Department of the Navy has furnished information that Aluminum Alloys, 5052, 5056, 5356, 6061, and 6063 covered by MS 33586 are similar to magnesium, and that aluminum foil 1100 alloy (2S) is dissimilar to magnesium.

(10) One of the newer materials which may be used as a greaseproof wrap is a transparent, heat-sealable film conforming to Specification MIL-B-22191. Type II, waterproof and greaseproof, meets the requirements of Method I.

(11) For tests applicable to Method I packages (table 3-11 and para 3-36).

NOTE

Parts coated with preservative compounds should never be wrapped before the coatings have set or excess preservative oils have drained from cavities and recesses.

3-8. Method IA, Water-Vaporproof Inclosure (With Preservative as Required)

a. Concept of Method IA. Method IA is a water-vaporproof inclosure in which the items, with or without a preservative coating, are placed. Unless otherwise specified, preservative compounds shall not be used for submethods IA-5, IA-8, IA-13, IA-14, IA-15, and IA-16. The inclosure may be a rigid container or a water-vaporproof barrier, depending on the submethod being used.

b. When To Apply Method IA. Method IA unit packing is intended to afford protection to metallic and nonmetallic items against deterioration caused by water or water vapor and by natural and industrial contaminates and pollutants. Method IA, supplemented by contact preservatives, is applied to parts and equipment where critical functioning metal surfaces, held to close tolerances, are involved. Composite items possessing fabric, rubber, plastic, or other nonmetallic components, which would be damaged by a contact preservative, are packed by Method IA, without a preservative. Method IA prescribes that the part or equipment be enclosed in an overall water-vaporproof barrier. When contact preservatives are used in Method IA, they should be selected from those preservatives which may be easily removed, if removal will be necessary before putting the item into use. Metallic items which are too complex to be completely covered by a preservative coating, and which require the utmost protection in storage and shipment, should be packed by the use of a water-vaporproof pack including desiccant, and with preservative when required (Method II). While Method IA was originally intended to prevent corrosion on metal parts, it is used without a contact preservative to keep fabric, paper, plastic, and other nonmetallic items clean and dry during shipment and storage. When packed by this method, the life of rubber articles is extended inasmuch as gases, such as ozone, which accelerate the deterioration of rubber, will not readily penetrate the Method IA barriers. Water-vaporproof barrier materials conforming to MIL-B-81705, which are fabricated with electrically conductive surfaces and one or more laminates of aluminum foil, provide safeguards against electrostatic damage as well as a degree of protection from electromagnetic radiation. In all uses of Method IA, the barrier should be formed around the item so that the pack will contain a minimum of air volume. If the area

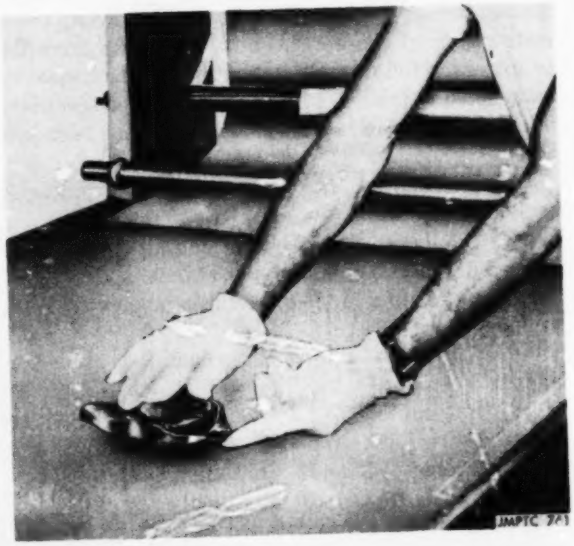


Figure 3-20. Method I wraps—conform wrap to shape of item.

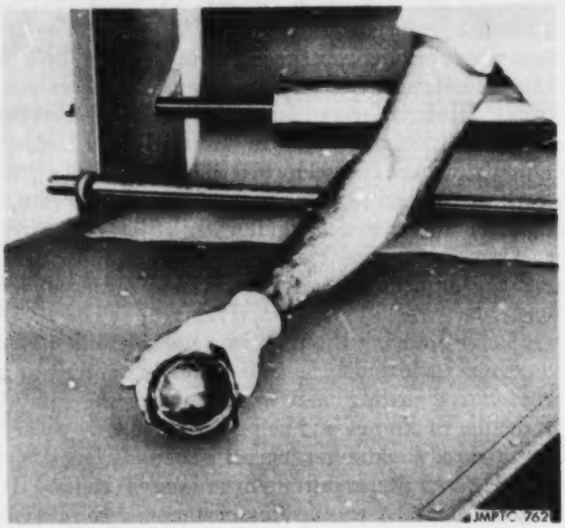


Figure 3-21. Method I wraps—include minimum of air volume.

of the barrier or the volume of enclosed air is large, the amount of water vapor contained in the pack or subsequently transmitted through the barrier will be large. Consequently, condensation will occur within the pack when it becomes chilled.

c. *Submethods Under Basic Method IA.* Seven applications of Method IA are used. They are employed with or without contact preservatives, as required, except for submethod IA-6, where a preservative is always used. Before any preservation, all parts and equipment shall be properly cleaned and dried according to the instruction of chapter 1. When required, a contact preservative shall be applied according to the instructions of chapter 2. Packs completed according to any of the following IA submethods, which meet the tests listed in table 3-11 will be considered acceptable in cases where Method IA preservation has been indicated:

(1) *Submethod IA-5.* Rigid metal container, sealed.

(2) *Submethod IA-6.* Rigid container (items immersed in preservative, oil type), sealed.

(3) *Submethod IA-8.* Water-vaporproof bag, sealed.

(4) *Submethod IA-13.* Rigid container other than all-metal, sealed.

(5) *Submethod IA-14.* Container, bag, sealed container.

(6) *Submethod IA-15.* Container, bag, sealed.

(7) *Submethod IA-16.* Floating bag, sealed.

It is recommended that detailed steps involved in the application of all IA submethods be followed carefully for consistent satisfactory results.

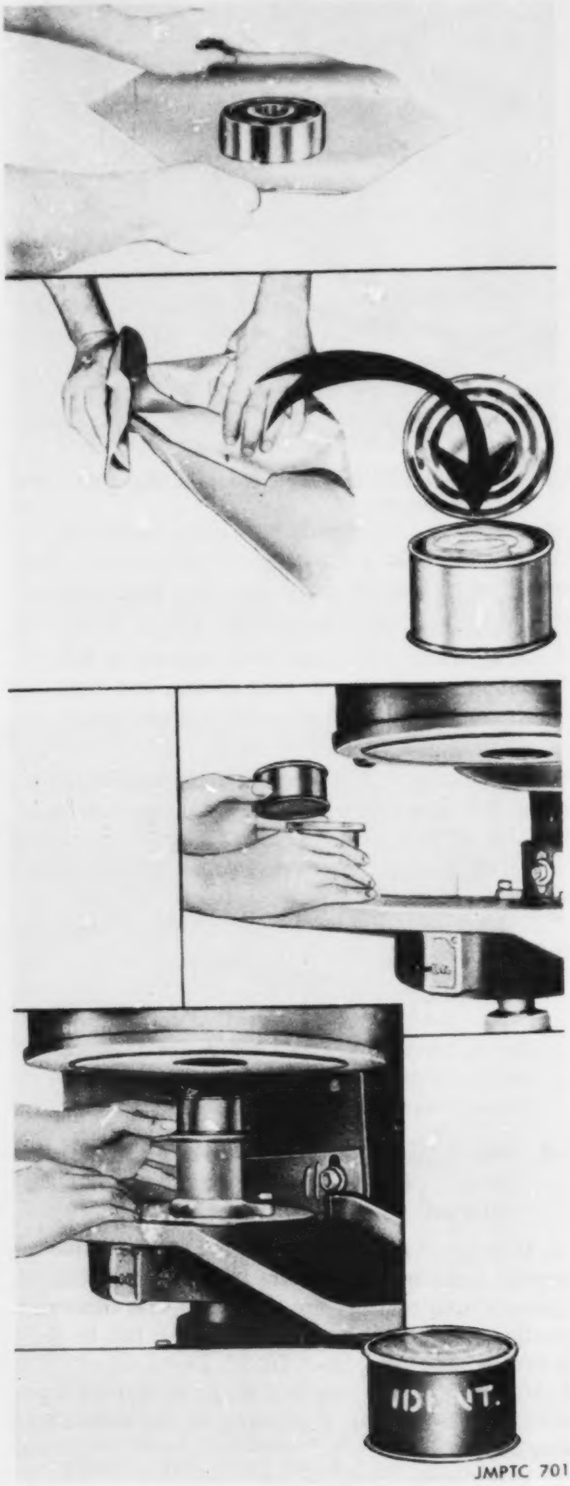


Figure 3-22. Application of submethod IA-5.

3-9. Submethod IA-5, Rigid metal Container, Sealed

a. Materials Needed for Submethod IA-5.

(1) Barrier material conforming to Grade A of MIL-B-121 shall be used on items requiring a contact preservative. The type selected will depend upon the strength required to do a satisfactory job. When applicable, aluminum foil, QQ-A-1876 may be used as an alternate. QQ-A-1876 material should be used with caution because of its reaction with certain metals (para 3-7*d*). Type II of MIL-B-22191 may also be used.

(2) When greaseproofness is not a requirement, neutral papers conforming to MIL-P-130, MIL-P-17667, and Type II of UU-P-553 meet the compatibility requirements of MIL-P-116. These papers are intended as an initial wrap where a noncorrosive, dust protective wrap is required prior to, or as a part of unit packaging wherein a greaseproof wrap is not required.

(3) Cushioning materials should be selected in accordance with the requirements in paragraph 3-5*d*. Only dry, noncorrosive cushioning materials should be used.

(4) The container is any type of rigid metal container with machine seamed closure or reusable gasketed closure, unless a particular type of container and closure has been specified by the procuring activity. The container, being metal, must be preserved against corrosion. Internal protection is provided at the manufacturing site. External protection is provided by coating or treating the exposed surfaces as required by the applicable specification.

b. How To Apply Submethod IA-5 (fig 3-22).

(1) After the contact preservative, if used, has set, the item should be wrapped in grade A of MIL-B-121 greaseproof barrier material. If the item is not preserved, the wrapping material in direct contact with it should be capable of meeting the requirements of Test Method 3005 of Federal Test Method Standard 101.

(2) Cushioning materials are used to protect fragile items and to control movement within the container. Examples of cushioning materials used in this submethod are cellulosic wadding, bonded hair, fiberglass, and rubber foams.

(3) Once the item has been wrapped and cushioned in the container, the closure is made. In many in-

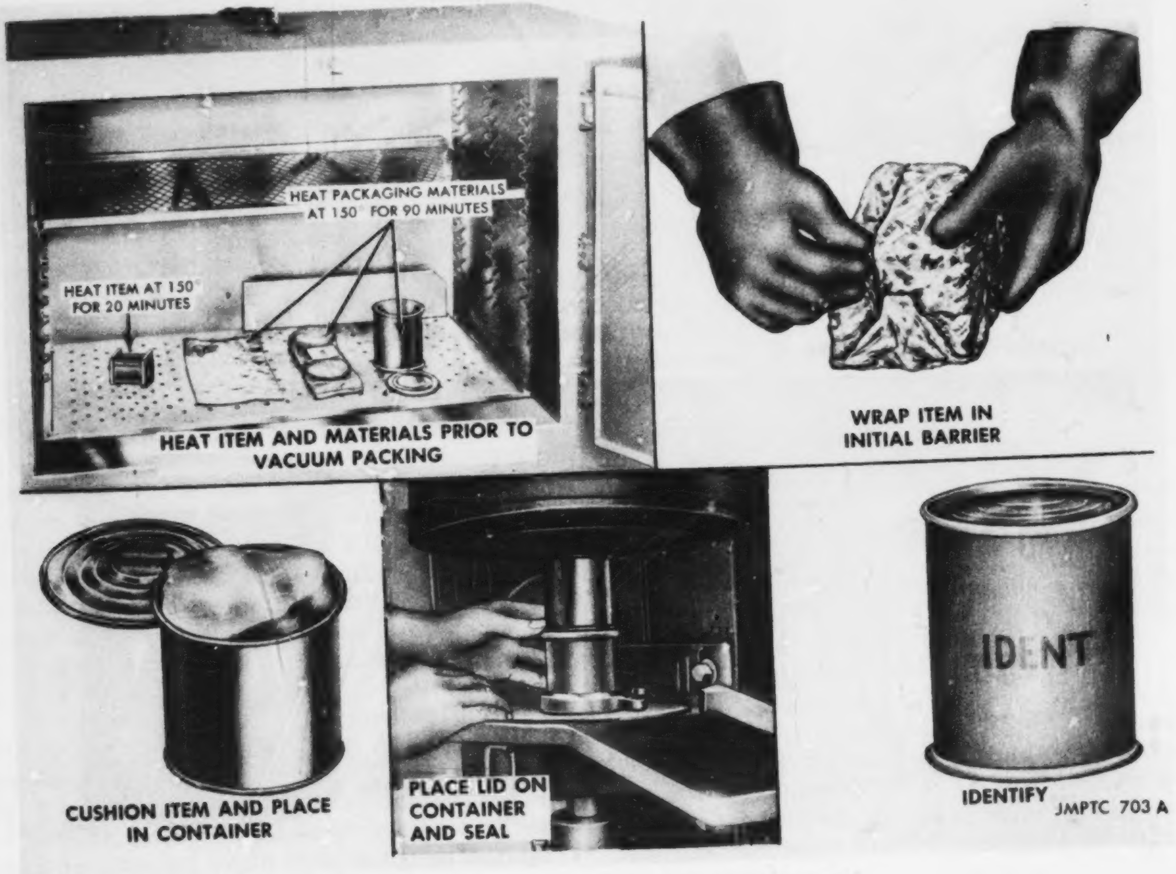

HEAT PACKAGING MATERIALS AT 150° FOR 90 MINUTES
HEAT ITEM AT 150 FOR 20 MINUTES
HEAT ITEM AND MATERIALS PRIOR TO VACUUM PACKING
WRAP ITEM IN INITIAL BARRIER
CUSHION ITEM AND PLACE IN CONTAINER
PLACE LID ON CONTAINER AND SEAL
IDENT
IDENTIFY
JMPTC 703 A

Figure 3-23. Application of submethod AIA-5, vacuum packed.

stances, special equipment is required to make the closure.

(4) The container is identified by lithographing, embossing, roller coating, or stamping with a weather-resistant, waterproof ink. Paper labels should not be used on metal containers unless directed.

(5) When specified or when dictated by requirements of contents, the metal container shall be vacuum sealed, as illustrated in figure 3-23.

3-10. Submethod IA-6, Rigid Container (Items Immersed in Preservative, Oil Type), Sealed

a. Materials Needed for Submethod IA-6.

(1) The preservative used should be of the oil type, and of such a nature that it will provide protection to the item under extreme climatic conditions. The use of the preservative oil increases the weight of the pack and this increased weight should be considered when selecting this submethod of packing.

(2) Cushioning materials are not used because the preservative oil serves the dual purpose of preserving and cushioning.

(3) The container selected should be of such a nature that it will retain the preservative oil, and be rigid enough to withstand the performance tests required for submethod IA-6 pack. Metal cans conforming to Specifications MIL-C-26094 and PPP-C-96, Type 1, and metal drums conforming to Specifications MIL-D-6055 and MIL-D-6054 may be used. Containers other than all-metal must be approved by the procuring agency prior to use.

(4) Specification MIL-B-197 (Bearing, Antifriction, Associated Parts and Subassemblies: Packaging Of) allows the use of vials constructed of either glass or transparent rigid plastic, and multiple-compartment containers made of 15 mil thick cellulose acetate butyrate, cellulose acetate, nylon or mylar, individually sealed (submethod IC-7 para 3-22).

b. How To Apply Submethod IA-6 (fig 3-24).

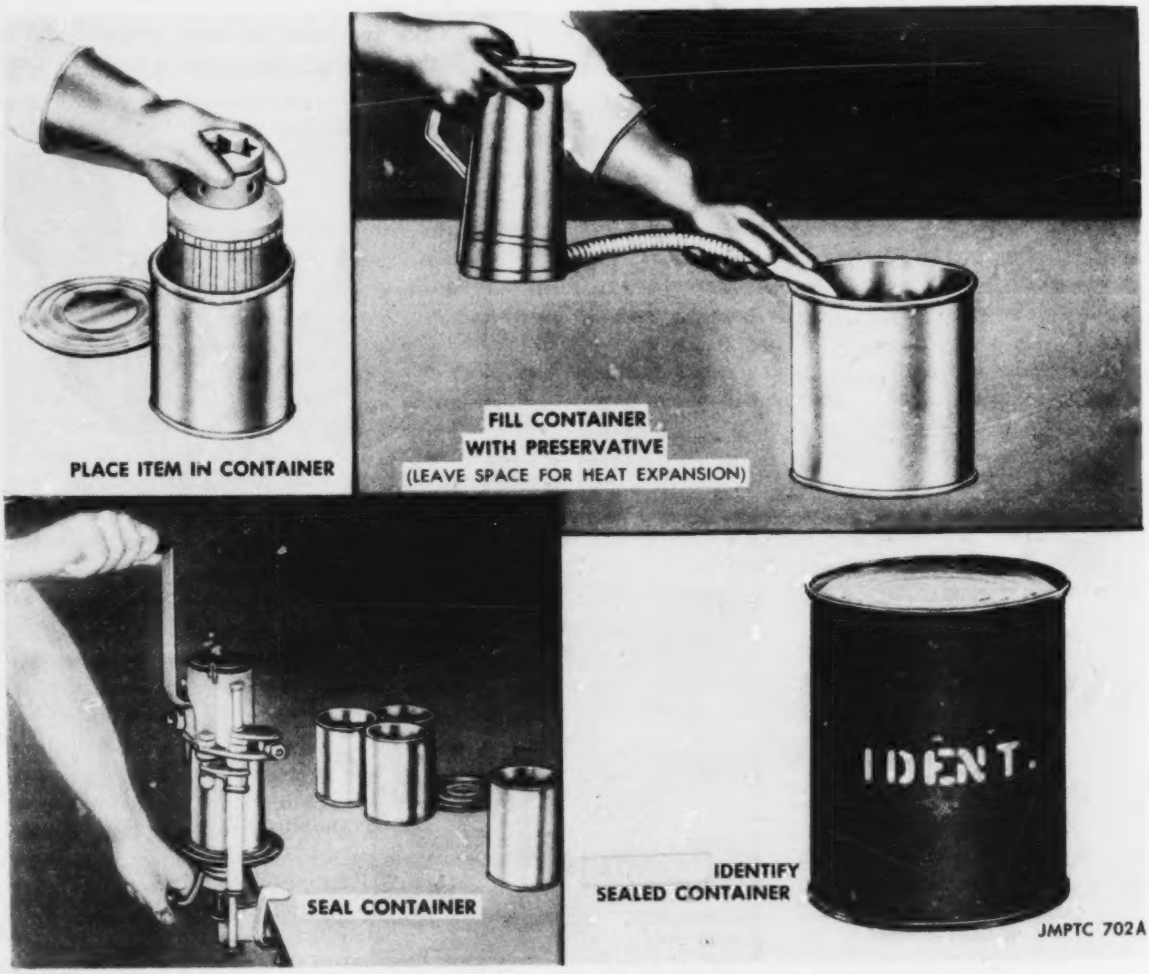

PLACE ITEM IN CONTAINER
FILL CONTAINER WITH PRESERVATIVE
(LEAVE SPACE FOR HEAT EXPANSION)
SEAL CONTAINER
IDENT.
IDENTIFY SEALED CONTAINER
JMPTC 702A

Figure 3-24. Application of submethod IA-6.

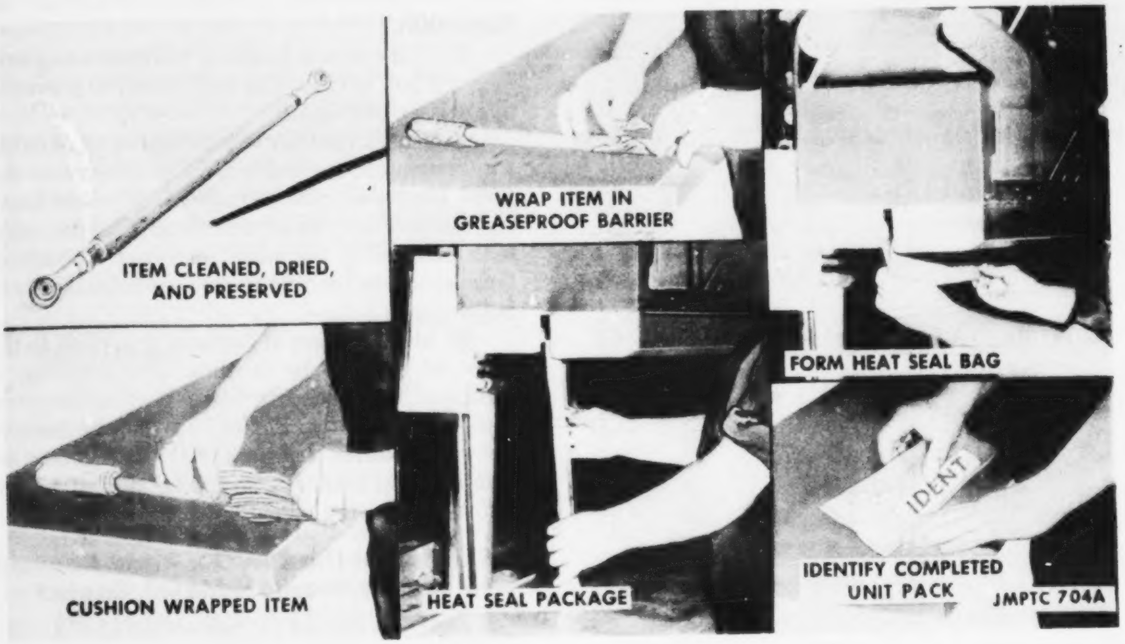

ITEM CLEANED, DRIED, AND PRESERVED
WRAP ITEM IN GREASEPROOF BARRIER
FORM HEAT SEAL BAG
IDENT
CUSHION WRAPPED ITEM
HEAT SEAL PACKAGE
IDENTIFY COMPLETED UNIT PACK
JMPTC 704A

Figure 3-25. Application of submethod IA-8.

(1) The rigid container should be partially filled with the preservative oil; the item is then placed in the container. Additional preservative oil should be added, as necessary, to insure complete coverage of the item.

CAUTION

In filing a container, a 5 to 7 percent void should be provided to permit thermal expansion.

(2) The container should be identified according to the type of rigid container used. Paper labels should not be used on metal containers unless specified by the procuring activity. If other than metal containers are used, the labels should be applied with adhesive conforming to Specifications MMM-A-178 or MMM-A-105. Stenciling, lithographing, embossing, roller coating, or stamping with weather-resistant, waterproof ink are preferred methods of identification of either metallic or nonmetallic containers (table 3-11 and para 3-46).

(3) Glass or transparent rigid plastic vials, when used for the packaging of bearings, shall have an inside diameter of not less than 0.010 inch nor more than 0.025 inch greater than the outside diameter of the contained bearings. The height of the vial shall not exceed the combined height of the contained bearings by more than ½ inch.

3-11. Submethod IA-8, Water-Vaporproof Bag, Sealed

a. Materials Needed for Submethod IA-8.

(1) Item(s) wrapped and cushioned as required shall be enclosed in a sealed bag conforming to MIL-B-117, Types I, II or III, Class E, F or G style 1, 2, or 3.

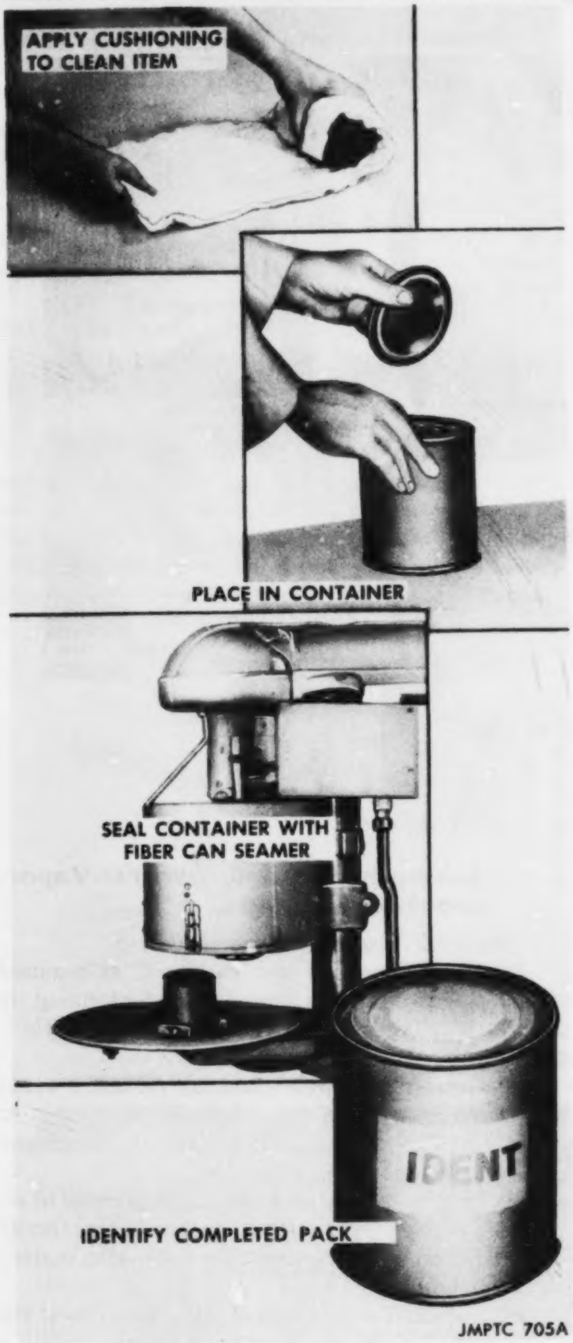
(2) Greaseproof barrier materials for initial wraps will conform to Specification MIL-B-121, Grade A; QQ-A-1876; or MIL-B-22191, Type II. Nongreaseproof barriers shall be noncorrosive.

(3) Cushioning materials should be selected in accordance with the requirements outlined in paragraph 3-5*d*. Only clean dry, noncorrosive cushioning materials should be used.

(4) Class E, F and G bags of MIL-B-117 meet the requirements for the watervaporproof bag.

b. How To Apply Submethod IA-8 (fig 3-25).

(1) This submethod will be accomplished by inserting the item, wrapped and cushioned, as necessary, into the water-vaporproof bag, exhausting the excess air, and closing the bag. Items packed by submethod IA-8 are generally light in weight and flat in shape, so as to lend themselves to easy insertion into the flat or envelope-type bag.


APPLY CUSHIONING TO CLEAN ITEM
PLACE IN CONTAINER
SEAL CONTAINER WITH FIBER CAN SEAMER
IDENT
IDENTIFY COMPLETED PACK
JMPTC 705A

3-26. Application of submethod IA-13.

(2) The item will be cleaned, dried, and preserved when required. When the item is preserved, care should be taken to prevent rubbing and preserve against the heat seal edge of the bag closure. Preliminary greaseproof wraps applied to confine the preservative onto the surface of the items are not necessary when bags are made of MIL-B-131, MIL-B-22191 or MIL-B-81916 barrier material, as is the case in this submethod.

(3) If the item is fragile or has protruding or sharp edges, it will be cushioned sufficiently to prevent damage to itself and the bag.

(4) The inclosed air within the bag must be held to a minimum and the seal must be as effective as the bag itself. Heat seals must be made at the proper heat sealing temperature, dwell time, and pressure. Settings recommended by the manufacturer of the barrier material should be used cautiously due to points discussed in paragraph 3-6*g*.

(5) Identification of contents is applied to the exterior of the bag by labeling, lithographing, hand stamping, roller coating, embossing, or stenciling. If automatic equipment is used, care must be exercised to prevent rupturing the bag (table 3-11 and para 3-46). Identification markings should be applied to the bag before the item is inserted.

3-12. Submethod IA-13, Rigid Container, Other Than All-Metal, Sealed

a. Materials Needed for Submethod IA-13.

(1) Greaseproof barrier material conforming to Specification MIL-B-121, Grade A; MIL-B-22191, Type II; or QQ-A-1876 should be used as the initial wrap for preservative coated items. QQ-A-1876 material should be used with caution because of its reaction with certain metals (para 3-7*d*).

(2) Noncorrosive barrier material conforming to Specification MIL-P-130, MIL-P-17667 or UU-P-553, Type II, may be used for wrapping items requiring no preservative.

(3) Cushioning material should be selected in accordance with the requirements in paragraph 3-5d. Only dry, noncorrosive cushioning material should be used.

(4) Fiber containers, for items less than 20 pounds, shall conform to Specification MIL-C-3955, Type I, Grade B. For heavier items fiber containers conforming to PPP-D-723 Type III, Grade A, class 2 shall be used. Other sealed rigid containers may be used when the sealed barrier provides a WVTR not exceeding 0.07 grams per 100 square inches per 24 hours, as established by Government specifications, or when tested in accordance with method 5021 of Federal Test Method Standard No. 101.

(5) The container must be capable of passing the performance tests required for submethod IA-13 packs (table 3-11).

(6) If a greaseproof liner is required for a MIL-C-3955 container it shall be made from material conforming to MIL-L-45973.

b. How To Apply Submethod IA-13 (fig 3-26).

(1) The item should be initially wrapped with the appropriate barrier material.

(2) Cushioning material is used to protect delicate or fragile items and to control movement within the container.

(3) Once the item has been wrapped and cushioned in the container, the closure is made. Normally, special equipment is required to make the closure.

(4) Identification marking should be applied on the container. Markings may be applied by lithographing, embossing, roller coating, or stamping with weather-resistant, waterproof ink. Paper labels may also be used (table 3-11 and para 3-46).

3-13. Submethod IA-14, Container, Bag, Container

a. Materials Needed for Submethod IA-14.

(1) Greaseproof barrier material conforming to Specifications MIL-B-121. Grade A; MIL-B-22191; Type II; or QQ-A-1876 should be used as the initial wrap for preservative coated items. QQ-A-1876 material should be used with caution because of its reaction with certain metals (para 3-7*d*).

(2) Noncorrosive material conforming to Specification MIL-P-130, MIL-P-17667 or UU-P-553, Type II, may be used for wrapping items requiring no preservative.

(3) Cushioning materials should be selected in accordance with the requirements in paragraph 3-5*d*. Only clean dry, noncorrosive cushioning material should be used.

(4) The bag will be close fitting, sealable, and fabricated in accordance with MIL-B-117, Type I, II or III, Class E, F or G, styles 1, 2 or 3. Sizes larger than permitted by MIL-B-117 shall conform to MIL-E-6060.

(5) Cartons or boxes for the inner and outer containers will be consistent with the weight of the item and the degree of protection required.

(6) When the item is provided with the rigid inclosure, which affords protection equal to that of a carton or a box, such as an instrument box or a carrying case, the rigid inclosure may be used as the inner container. When this is done, the item must be properly secured within the inclosure; the inclosure must be properly wrapped or cushioned to prevent rupture or chafing of the barrier bag; and the inclosure must be properly locked or taped to prevent spilling of the contents within the bag.

(7) When a wooden box is used as the outer container, a liner or over wrap of heavy kraft paper will be provided for the bag to prevent chafing of the barrier material. Closure of the box will not damage the bag and will be in accordance with the applicable specification.

b. How To Apply Submethod IA-14 (fig 3-27).

(1) The item should be initially wrapped with the appropriate barrier material.

(2) Cushioning material is used to protect delicate or fragile items and to control movement within the container.

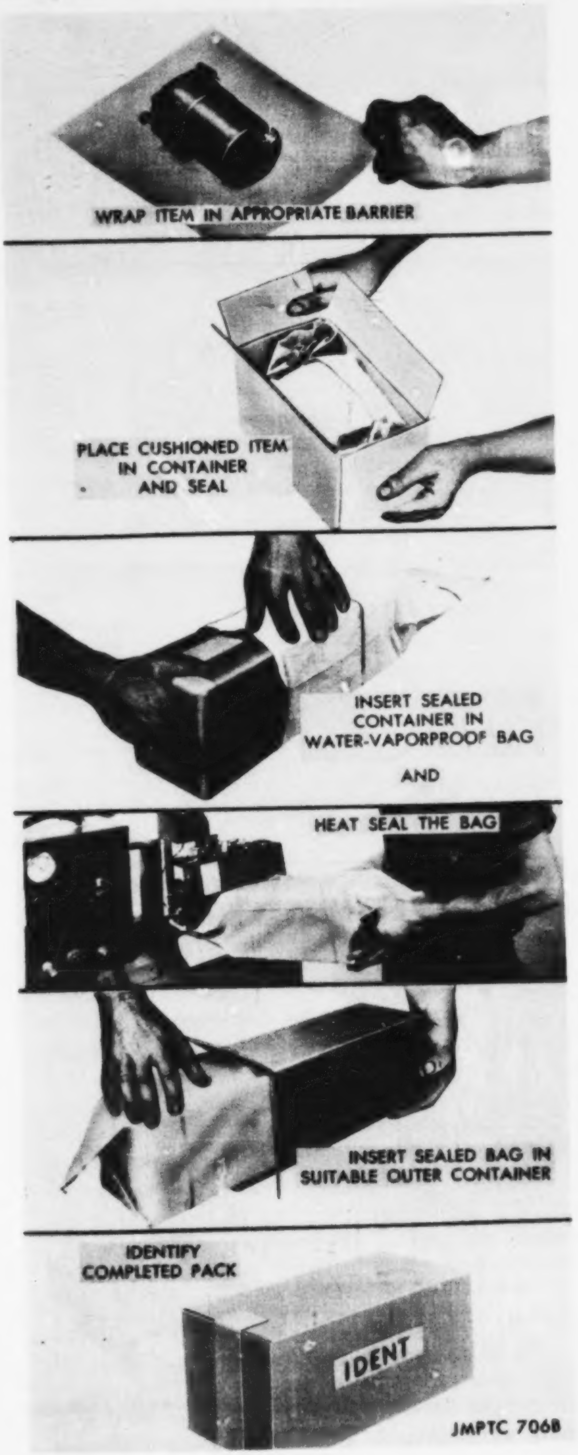

WRAP ITEM IN APPROPRIATE BARRIER
PLACE CUSHIONED ITEM IN CONTAINER AND SEAL
INSERT SEALED CONTAINER IN WATER-VAPORPROOF BAG
AND
HEAT SEAL THE BAG
INSERT SEALED BAG IN SUITABLE OUTER CONTAINER
IDENTIFY COMPLETED PACK
IDENT
JMPTC 7068

Figure 3-27. Application of submethod IA-14.

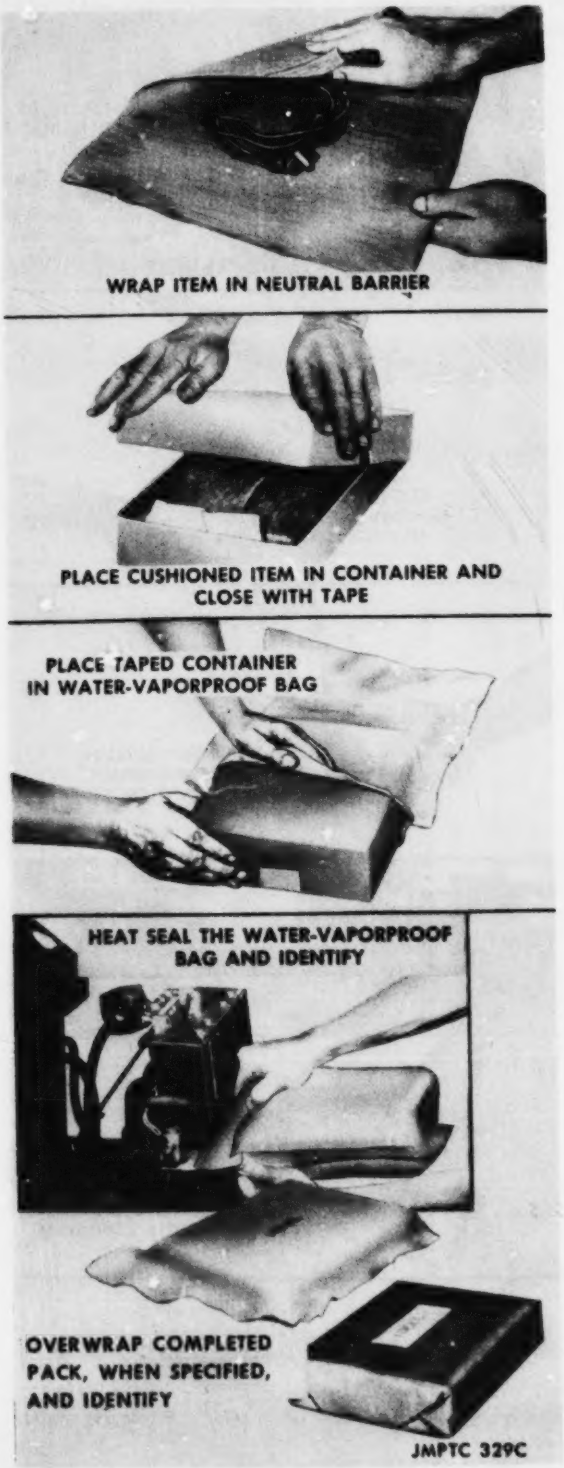

WRAP ITEM IN NEUTRAL BARRIER
PLACE CUSHIONED ITEM IN CONTAINER AND CLOSE WITH TAPE
PLACE TAPED CONTAINER IN WATER-VAPORPROOF BAG
HEAT SEAL THE WATER-VAPORPROOF BAG AND IDENTIFY
OVERWRAP COMPLETED PACK, WHEN SPECIFIED, AND IDENTIFY
JMPTC 329C

Figure 3-28. Application of submethod IA-15.

(3) All corners of the carton or box used as the inner container should be rounded or "mashed" prior to putting the item in a snug fitting carton or box to preclude rupturing of the barrier material. The metal stitches inside the outer container should be covered with tape or other material to protect the bag from rupturing.

(4) When inclosing the inner container within the water-vaporproof bag, it is necessary to exhaust as much of the air from the bag as possible.

(5) The outer container shall be closed in such a manner that damage to the water-vaporproof bag inclosing the inner container is not possible.

(6) Identification markings should be applied on the bag and also on the outer container (table 3-11 and para 3-46).

3-14. Submethod IA-15, Container, Bag, Sealed

The materials and application procedures for submethod IA-15, are the same as for submethod IA-14, except that the outer container is omitted. When an overwrap is specified in the contract, it should be secured with tape, twine, or other authorized means (fig 3-28).

3-15. Submethod IA-16, Floating Bag, Sealed

a. *Materials Needed for Submethod IA-16.*

(1) When a preservative is required, a greaseproof barrier conforming to Specifications MIL-B-121, Grade A; MIL-B-22191, Type II; or QQ-A-1876 should be used as the initial wrap. QQ-A-1876 material should be used with caution because of its reaction with certain metals (para 3-7*d*).

(2) Cushioning materials should be selected in accordance with the requirements in paragraph 3-5*d*. Only dry, noncorrosive cushioning material should be used.

(3) Item(s) wrapped and cushioned as required shall be enclosed in a sealed bag conforming to MIL-B-117, Types I or II, Style 1 Class E, F or G, style 1 or 2. Larger bags shall be in accordance with MIL-E-6060. The bag shall be provided with gasketted holes to permit the installation of the barrier over and around the fasteners used to secure the item(s) within the container.

(4) Gasket material used in sealing the barrier to interior supports or to one face of the container will conform to Specification MIL-G-12803 when specified, except gaskets for Naval applicated will be asbestos free.

b. *How To Apply Submethod IA-16 (fig 3-29).*

(1) Submethod IA-16 is fabricated similar to submethod IIa (para 3-26), except that desiccant is not

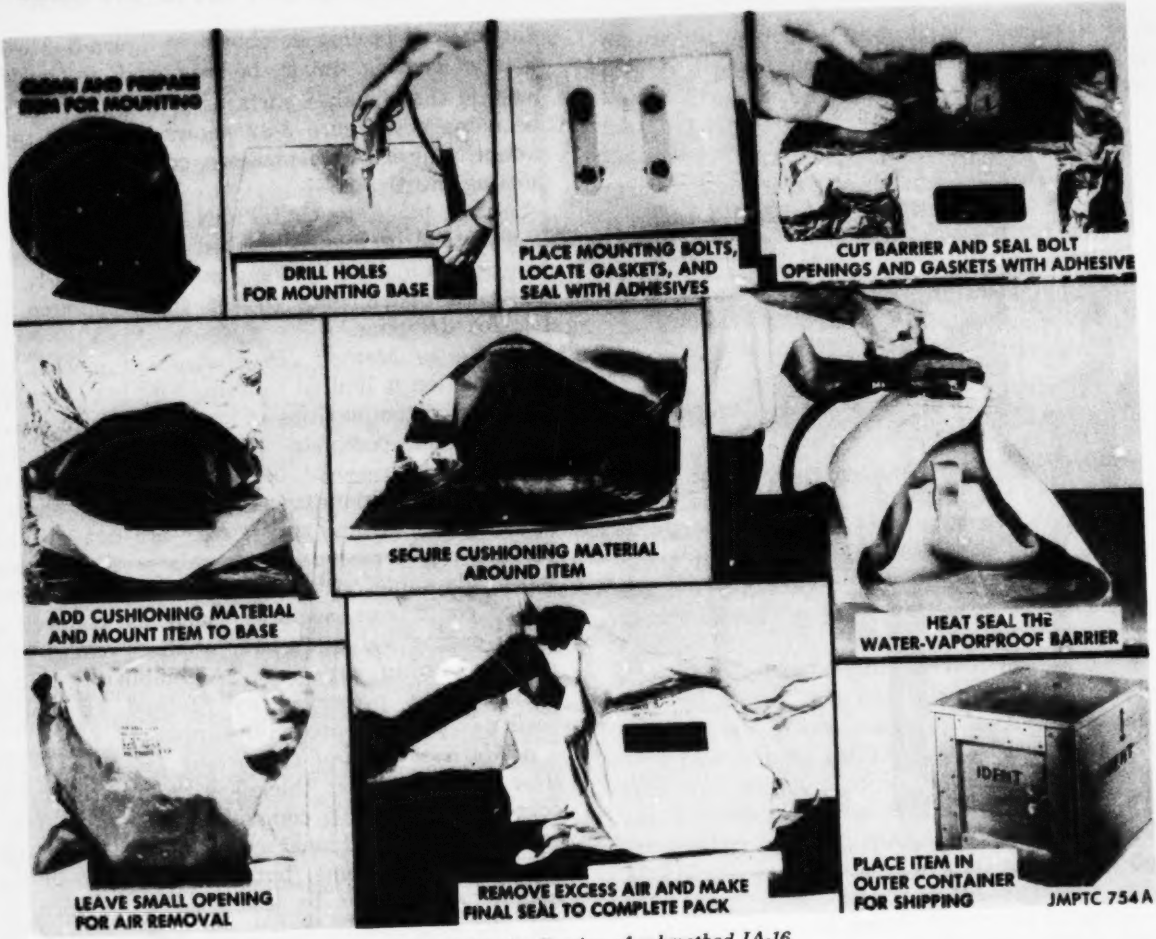

CLEAN AND PREPARE ITEM FOR MOUNTING
DRILL HOLES FOR MOUNTING BASE
PLACE MOUNTING BOLTS, LOCATE GASKETS, AND SEAL WITH ADHESIVES
CUT BARRIER AND SEAL BOLT OPENINGS AND GASKETS WITH ADHESIVE
SECURE CUSHIONING MATERIAL AROUND ITEM
ADD CUSHIONING MATERIAL AND MOUNT ITEM TO BASE
HEAT SEAL THE WATER-VAPORPROOF BARRIER
LEAVE SMALL OPENING FOR AIR REMOVAL
REMOVE EXCESS AIR AND MAKE FINAL SEAL TO COMPLETE PACK
PLACE ITEM IN OUTER CONTAINER FOR SHIPPING
IDENT
JMPTC 754A

Figure 3-29. Application of submethod IA-16.

used. The barrier is provided with gasketed holes through which the item is fastened to one face of the container, usually the base, or to an interior support within the container.

(2) Adhesive is used to affix gaskets between the barrier and the container, and between the barrier and the item. Gasket material shall conform to MIL-G-12803 unless otherwise specified. Adhesive conforming to Specification MMM-A-260 can be used on most fiber gaskets. MMM-A-1617 adhesive is recommended for rubber gaskets.

(3) Cushioning material should be used to cover all sharp edges and corners. Cushioning may be attached by means of tape or twine.

(4) The bag is formed by drawing the material around the item and sealing the vertical end seams. Air volume should be kept to a minimum before sealing the bag by withdrawing air either by hand pressure or a vacuum extractor.

(5) Identification markings should be applied on the floating barrier and on the exterior container (table 3-11 and para 3-46).

3-16. Method IB, Strippable Compound Coating (Hot or Cold Dip)

a. Description of Method IB. Method IB is effected by coating the prepared item with hot dipping compound conforming to Specification MIL-P-149, Type I or II. After the compound sets the item may be wrapped, boxed, or canned to retain the oil which exudes from the compound during storage. Coated items must be blocked, braced, or cushioned, as necessary, to insure that the static load on the compound does not exceed 30 pounds per square inch. The compound is applied in such a manner that, when removed, none will be retained in crevices, oil holes, or similar cavities. For tests applicable to method IB packs, see table 3-11 and paragraph 3-36. The protective coating is obtained by dipping the item in a tank (fig 3-30) of melted plastic heated to the specified temperature. In dipping, the item is suspended by a nonwicking cord or a nonhygroscopic material approved by the activity con-

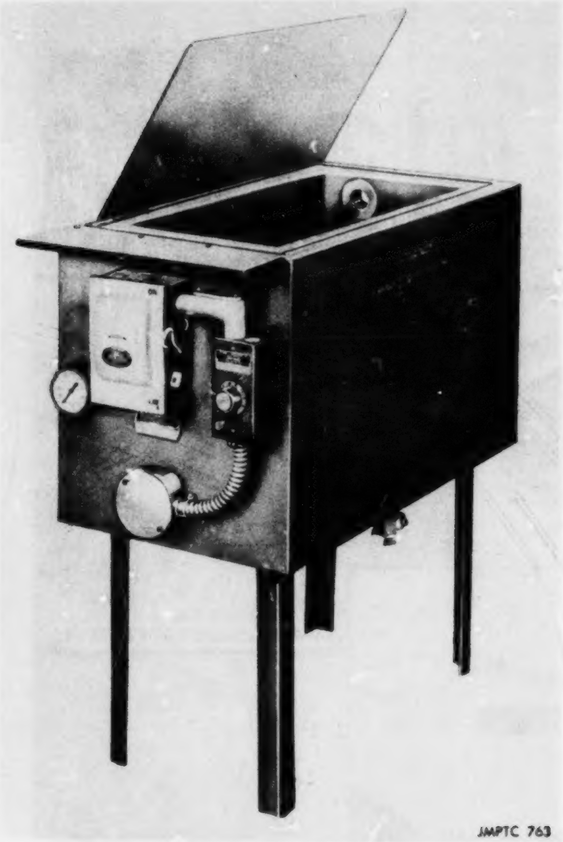


Figure 3-30. Typical hot-dip tank for preservative and plastic compounds.

cerned. Preparation of commonly used cord materials, e.g., cotton, flax, linen, and spun glass, may be accomplished by placing the cord material in an oven heated to a temperature of 160°F. for a period sufficient to remove all traces of moisture, usually from 2 to 6 hours, depending on the volume of material involved. Immediately after this preparation the condage is impregnated by immersion in heated preservative compound conforming to class 3 of Specification MIL-C-11796. If necessary to remove excess compound, the cordage should be returned to the oven until the excess compound drains off. A check to determine if the cord is sufficiently dry is made by dipping a sample of the prepared cord in strippable compound; absence of bubbles underneath the compound is indication that the cord is dry. The cord should have a tensile strength of not less than four times the weight of the item to be suspended. However, in actual operation, a cord with a tensile strength of 30 pounds is ordinarily sufficient. The plastic should be allowed to set before packing or shelf stocking. Removal of the plastic coating at the time of use consists of slitting and peeling as shown in figure 3-31. The plastic coating must be removed in such a manner that finished surfaces of the item will not be damaged. Figure 3-32 shows an easily made wooden chisel which makes a convenient tool for slitting the plastic.

CAUTION

> Critical or highly finished surfaces must not be marred by using metal or similarly hard instruments to slit the compound for stripping.

b. Use of Method IB. The use of method IB preservation is limited to items that have no deep recesses or complexities of structure which would prevent the complete removal of the plastic. Articles which would be damaged by oil or by heating to temperatures up to 350°F.—electric coils, fuses, fabrics, paper, etc.—are not suitable for hot dip preservation by this method. Items most adaptable to this method are those with plain, continuous surfaces, such as connecting rods, engine valves, gears, shafts, yokes, cam shafts, bearing cups, etc. Assemblies will not ordinarily be preserved by Method IB unless their design and contour are simple.

c. Material Control Conditions for MIL-P-149 (Hot Dip). Sufficient thickness for a satisfactory coating of strippable compound is between 0.050 and 0.100 inch. Thinner coatings are acceptable on small, light items, but in no case, shall the minimum thickness be less than 0.025 inch on any surface. Coating thickness is determined by the dipping temperature, the immersion time, the mass or heat capacity of the part, and the

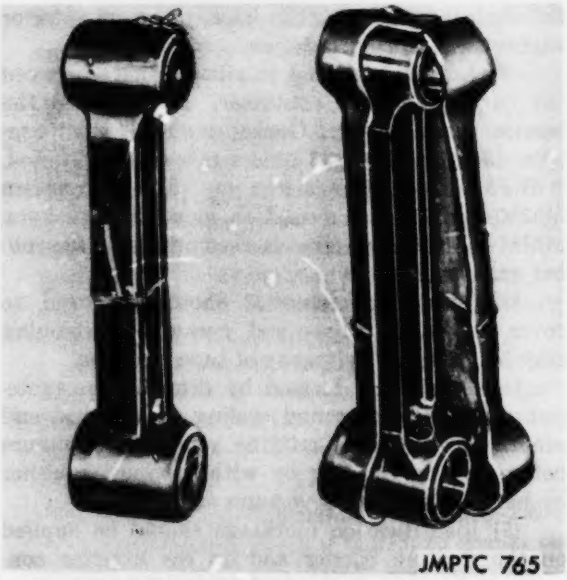


Figure 3-31. Slitting and peeling of strippable compound.

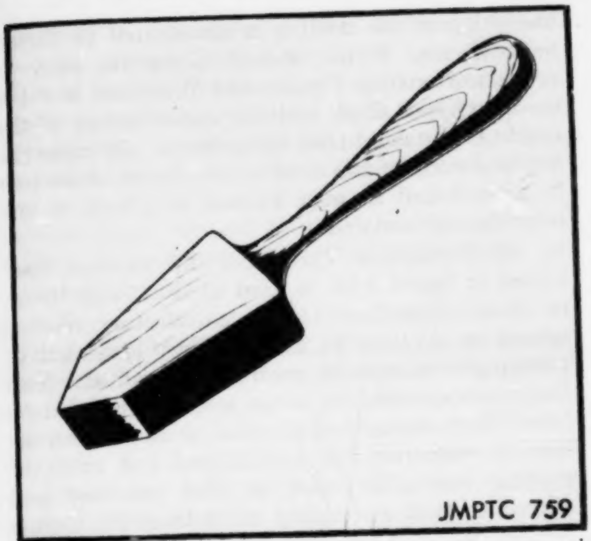


Figure 3-32. Wooden chisel for slitting strippable compound.

conditions of the compound. While an item is being dipped, it takes some of the heat from the melted plastic, and the longer the duration of the dip, the closer the temperature of the item approaches the temperature of the plastic, and the thinner the protective coating obtained. Conversely, a massive item, when dipped for the same period of time, will retain a temperature considerably lower than that of the plastic, resulting in a greater cooling action on the plastic during the "drainoff" period and a thicker protective coating. The ideal dipping temperature for MIL-P-149 is from 325°F to 350°F for the Type II material, and from 350°F to 375°F for the Type I material. The compounds will degrade when overheated and will not provide the necessary protection required of method IB packs. At no time will the temperature of the Type II material exceed 370°F and the temperature of the Type I material 390°F. Dipping tanks must be designed to hold the required amount of material at the required temperature without overheating any part of the material. This is usually accomplished by using a double walled, oil jacketed tank, electrically heated. When cold plastic is added to compensate for that removed by dipping, the additions must be made frequently and in relatively small quantities to prevent wide temperatue fluctuations in the tank. If a noninterrupted production is required, plastic may be pumped in from a preheated tank which melts the plastic and brings its temperature close to that of the dipping tank. When not in use, tanks may be kept at idling temperatures between 250°F and 275°F during the workday. A temperature range from 150°F to 250°F is recommended for overnight. The nature of the plastic permits it to be reused a number of times, and clipped tailings, stripped coatings, drippings, etc., can be reused provided they are not contaminated with oil, grease, or dirt. Under no circumstances shall plastic of any other formula be combined with the material. Neither will compounds furnished by different manufacturers be mixed. Impure or unlike compounds may cause phase separation or loss of the physical properties required of the material.

d. Coating With Strippable Compound. The high application temperature of strippable compound limits its application to dipping. Items are not to be preheated prior to coating since this will result in thin coatings that will not strip satisfactorily. If a heated solution or vapor has been used to clean the items, they must be cooled below 120°F before the plastic can be applied. Occasionally, an item may be encountered which would be ideally suited for preservation in accordance with Method IB, with the exception of a recess or a hole in it which might prove troublesome when the coating is stripped. In such cases, a high temperature grease (melting point above 350°F) or a plastic plug can be used to close the cavity and thus permit dipping of the item. The grease can be removed after the protective coating has been stripped by dipping the item in a solvent which will readily dissolve the grease. By doing this, many items, which would ordinarily require another method of preservation, can be satisfactorily protected with strippable compound. Items or assemblies may be coated with strippable compund either by a single complete dip or by a double-dip. The choice between the single-dip and the double-dip methods will depend upon the size, shape, weight, and area of the item to be coated.

(1) *Single-dip.* In the single-dip method, the item is suspended from a cord as shown in figure 3-33 and completely coated in one dip. The item should be immersed in such a position that the compound will reach all surfaces requiring the plastic coating. Dipping time should be short and ordinarily should not exceed 10 seconds. The draining position should prevent pocketing and should yield an even and continuous coating. Draining of excess compound from the item must not be allowed to flow back into the dipping section of the tank. No dipping should be done in a melted compound which shows air bubbles or which leaves air bubbles in the coating after the item has been dipped. Items are suspended by their cords until the coating has set and cooled so that handling will not cause pressure thinning or cutting of the protective coating. "Setting up" or

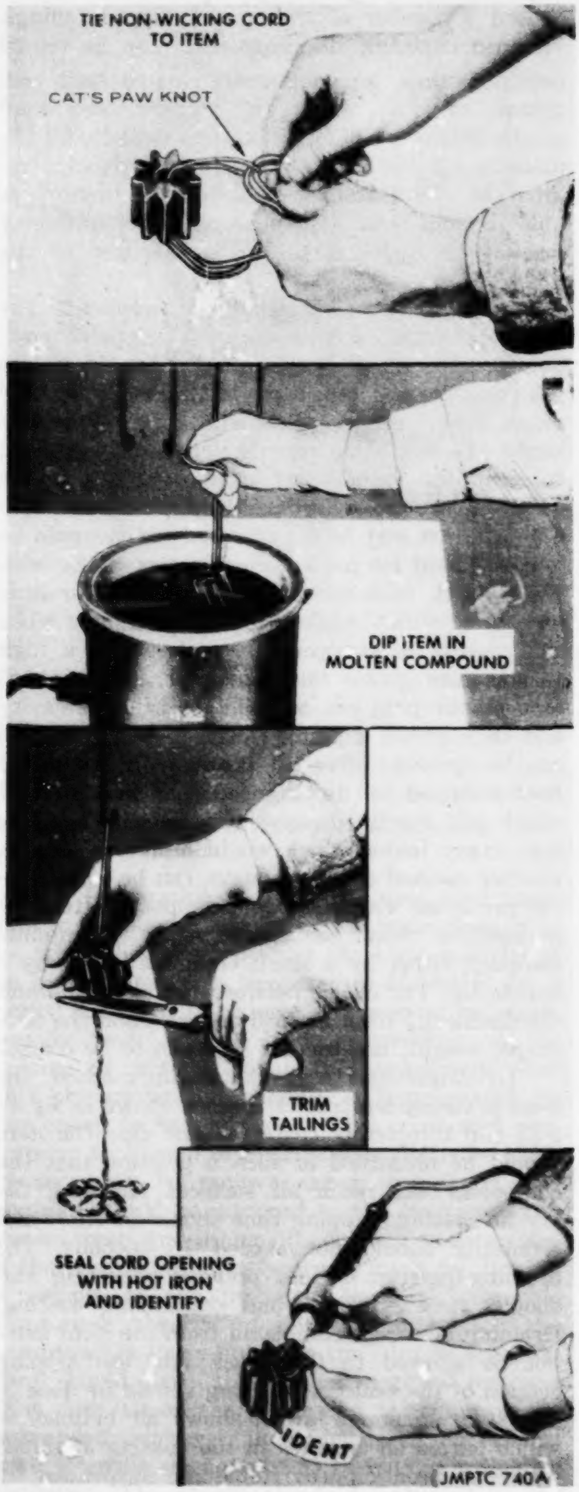

TIE NON-WICKING CORD TO ITEM
CAT'S PAW KNOT
DIP ITEM IN MOLTEN COMPOUND
TRIM TAILINGS
SEAL CORD OPENING WITH HOT IRON AND IDENTIFY
IDENT
JMPTC 740A

Figure 3-33. Submethod IB-1, Single-dip application.

hardening of the coating is accelerated by forced or cold air. Water should never be used to accelerate setting. Figure 3-33 illustrates how the cord is clipped flush with the outer surface of the coating. To insure that no moisture will enter the exposed ends of the cord, a low temperature iron is applied and a small amount of plastic is run over the exposed ends.

(2) *Double-dip.* The double-dip method, illustrated in figure 3-34, is used to coat large items, or items shaped so that a satisfactory coating cannot be obtained by a single dip. Clean cloth or rubber gloves must be worn to protect items from fingerprints when the items are being dipped by hand. First, one end of the item is dipped and the item is supported by its undipped end until the coating sets. The item is then reversed and dipped so that an overlap of at least 3/4 inch is formed. After the plastic sets, the item is placed on a table or a rack in such a way that the coating is not damaged.

e. Submethod IB-1, Direct application of strippable compound.

(1) This submethod is accomplished by applying the strippable coating directly to the surface of the item in such a manner that upon removal no compound will be retained in crevices, holes, or cavities (*e* above).

(2) The strippable compound may be applied by either the single-dip or double-dip method as described in *e*(1) and (2) above (fig 3-33 and 3-34).

f. Submethod IB-2, Aluminum Foil Wrap, Strippable Compound (fig 3-35). This submethod consists of applying the strippable compound over a conforming wrap of aluminum foil meeting the requirements of Specification QQ-A-1876. Unless otherwise specified, the application of a preservative compound is required. The function of the conforming wrap may serve four purposes—

(1) To prevent the contact preservative, if used, from being disturbed by the hot compound.

(2) To protect the strippable coating by covering sharp edges of the item.

(3) To prevent the compound from being trapped in holes, crevices, etc., of the item.

(4) To precent the oil exuded by the compound from contacting the surface of the item. The strippable compound may be applied either by the single-dip or the double-dip method as described in *e*(1) and (2) above. When the double-dip method is used, the plastic should overlap at least 3/4 inch. When the single-dip method is used, the part is usually suspended by a cord. The type of cord to be used is described in *a* above. Care should be taken to prevent wicking of moisture through the clipped ends of the cord as

explained in *e*(1) above. If the aluminum foil is used to protect the plastic, it is recommended that a double thickness of aluminum foil be placed over the sharp edges of the item. In some cases, even a greater number of thicknesses may be necessary. If the foil is used to retain or protect a contact preservative, or to prevent the exudate from contacting the item, it must be applied in such a manner that it performs its intended function.

g. Degradation of Compound. At least once during each operating shift, sample items should be taken for strippability tests and compound degradation observations. Coated items should be allowed to stand at a temperature of 65°F to 80°F for 6 hours. The coating should then be compared for color with an original standard taken during the first half hour of operation of each manufacturer's lot or batch of strippable compound. Any marked deterioration of color should be investigated. In addition, the item set aside must be stripped. The coating must show no adhesion to any surface of the item. If there is any indication that the compound has degraded, either by a change in color or adhesion upon stripping, a flat metal panel should be dipped in the compound for 5 seconds, and the coating allowed to set at room temperature for 2 hours. The coating from one side of the panel is then stripped and bent at 180° over a zero radius (fold back upon itself). Any evidence of cracking of the compound will be cause for rejection of the remaining material in the sampled tank. All items coated with strippable compound should be given a final visual inspection for continuous and acceptable coatings before packing. Although the coating offers mechanical protection, if static loading is in excess of 30 pounds per square inch cushioning must be used to reduce the load concentration. Cushioning of heavy items may be accomplished by overdipping the supporting areas with strippable protective compound, or by overwrapping the dipped item with acceptable cushioning materials.

NOTE

> It is recommended that directions for removal of the strippable compound be included in each interior or exterior pack. Suggested wording is: "Item preserved Method IB. To remove protective coating, slit and peel, using wood or plastic chisel. DO NOT use sharp metal tools or solvents to remove the coating."

3-17. Method IC, Waterproof or Waterproof/Greaseproof Enclosure (With Preservative as Required)

a. Concept of Method IC. Method IC consists of inclosing the item in a waterproof barrier after the required cleaning, drying, application of preservative, and cushioning, as needed. The type of barrier depends on the submethod to be used. The key word in Method IC is "waterproof" which indicate that the item is protected from the damaging effects of water, but not from

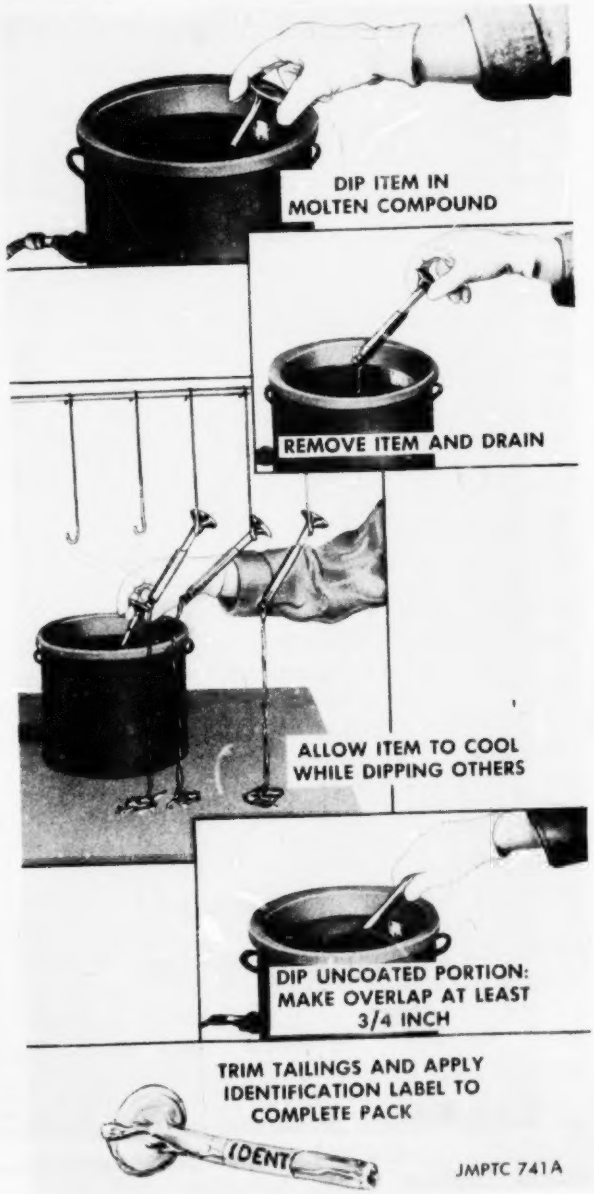

DIP ITEM IN MOLTEN COMPOUND
REMOVE ITEM AND DRAIN
ALLOW ITEM TO COOL WHILE DIPPING OTHERS
DIP UNCOATED PORTION: MAKE OVERLAP AT LEAST 3/4 INCH
TRIM TAILINGS AND APPLY IDENTIFICATION LABEL TO COMPLETE PACK
IDENT
JMPTC 741A

Figure 3-34. Submethod IB-1, double-dip application.

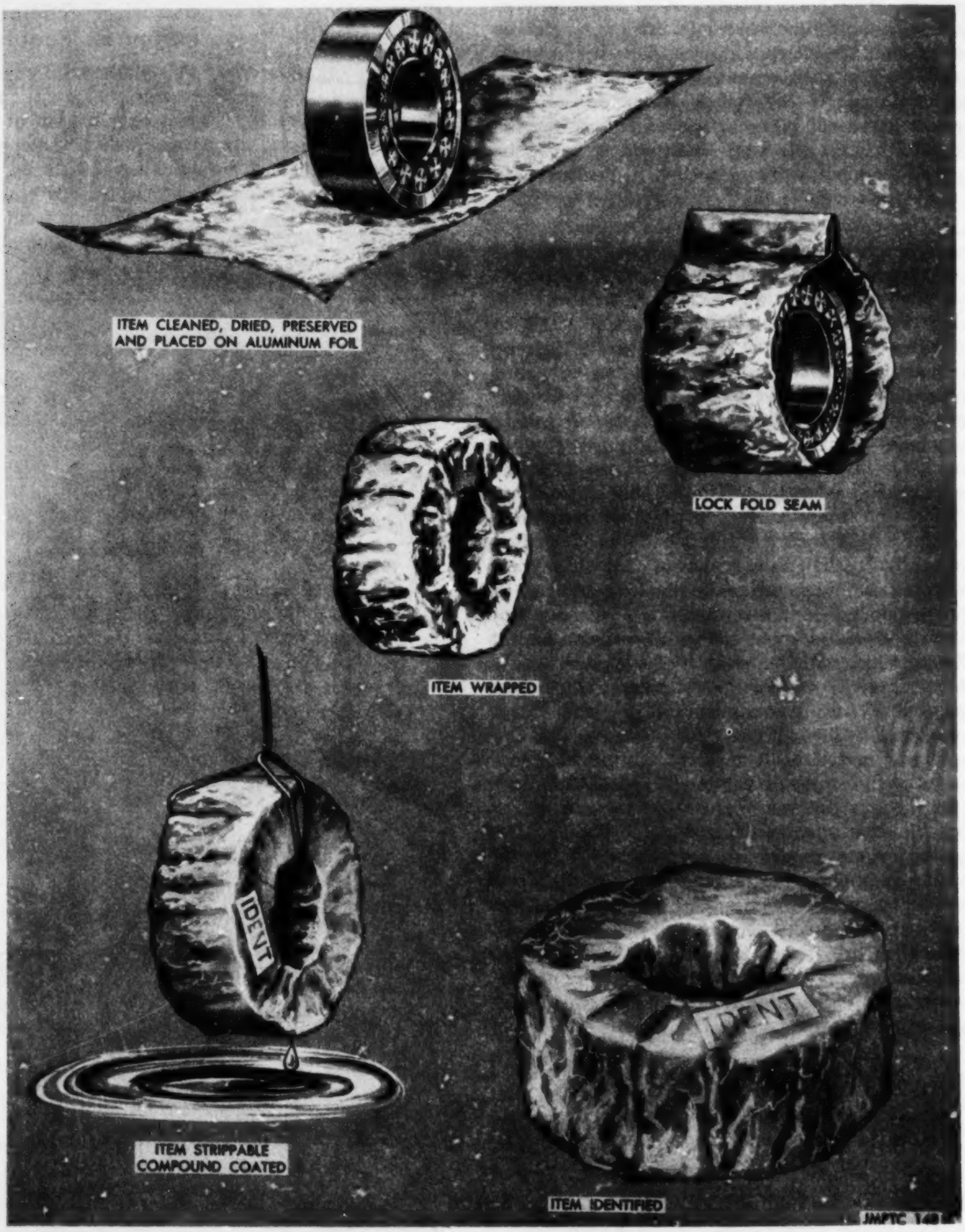

ITEM CLEANED, DRIED, PRESERVED AND PLACED ON ALUMINUM FOIL
LOCK FOLD SEAM
ITEM WRAPPED
IDENT
ITEM STRIPPABLE COMPOUND COATED
IDENT
ITEM IDENTIFIED
JMPTC 148

Figure 3-35. Application of submethod IB-2.

watervapor. For tests applicable to Method IC packs see table 3-11 and paragraphs 3-36.

b. Submethods Under Basic Method IC. Seven applications of Method IC are used with or without a preservative, as required. Unless otherwise specified in the particular submethod, the application of a preservative is required. Before any preservation, all items and equipment must be properly cleaned and dried according to the instructions of chapter 1. The submethods are as follows:

(1) IC-1. Greaseproof, waterproof bag, sealed.

(2) IC-2. Container, bag, sealed.

(3) IC-3. Waterproof bag, sealed.

(4) IC-4. Rigid container other than all metal, sealed.

(5) IC-7. Blister package—Single or multiple compartment individually sealed.

(6) IC-9. Skin package, greaseproof, waterproof, vacuum formed.

(7) IC-10. Skin package, waterproof, vacuum formed.

3-18. Submethod IC-1, Greaseproof, Waterproof Bag, Sealed

a. Materials Needed for Submethod IC-1.

(1) Greaseproof barrier material shall conform to Specification MIL-B-121, Grade A, or MIL-B-22191, Type II, Aluminum foil conforming to Specification QQ-A-1876 may also be used. Because of its reaction with certain metals, aluminum foil should be used with caution (para 3-7*d*).

(2) Cushioning materials should be selected in accordance with the requirements in paragraph 3-5*d*. Only clean dry, noncorrosive cushioning material should be used.

(3) The greaseproof, waterproof bag shall conform to MIL-B-117, Type I or II, Class C, style 1, 2, or 3, or MIL-B-22020 as limited by MIL-I-8574. .

b. How To Apply Submethod IC-1 (fig. 3-36).

(1) Greaseproof wraps applied solely to confine the preservative on the surface of the item are not necessary when bags are made of greaseproof material, as is the case in this submethod.

(2) Preserved items, not prewrapped, should be inserted into the bag through filler sleeves. Sealing difficulties will be eliminated if preservative films do not contact the edge of the bag closure.

(3) Cushioning material is applied to give protection to fragile items, and to prevent sharp edges of the item from puncturing the bag.

(4) Before the final closure is made, the air volume inside the bag should be reduced to a minimum.

(5) Identification of contents is applied to the bag by labeling, lithographing, hand stamping, roller coating, embossing, or stenciling. If automatic equipment is used, care must be exercised to prevent rupturing the bag. Identification will also be included on the outer container, when one is used to protect the bag (table 3-11 and para 3-46). Apply identification markings on bag prior to inserting item.

3-19. Submethod IC-2, Container, Bag Sealed

a. Materials Needed for Submethod IC-2.

(1) Greaseproof barrier material conforming to Specification MIL-B-121, Grade A, or MIL-B-22191, Type II, should be applied over preservative coated items.

(2) Aluminum foil conforming to Specification QQ-A-1876 may be used in lieu of MIL-B-121. Because of its reaction with certain metals, caution must be used in its application (para 3-7*d*).

(3) Material conforming to Specifications MIL-P-130, MIL-P-17667 or UU-P-553, Type II, may be used where noncorrosive wrap is desired for items not requiring a contact preservative.

(4) Cushioning material should be selected in accordance with the requirements in paragraph 3-5*d*. Only clean, dry, noncorrosive cushioning material should be used.

(5) The container, whether a folding, set-up or fiberboard box, should give the necessary physical and mechanical protection to the item.

(6) The bag will conform to MIL-B-117, Types I or II Class B or C, Style 1, 2 or 3.

b. How to Apply Submethod IC-2 (fig 3-37).

(1) Packaging materials in contact with uncoated metallic parts should meet the noncorrosive requirements of test method 3005 of Federal Test Method Standard 101. Coated parts should be initially wrapped in greaseproof barrier material.

(2) Cushioning material should be applied to protect fragile items and control movement within the snug fitting container.

(3) The container should be sealed in the manner prescribed in the applicable container specification.

(4) The corners of the container shall be blunted prior to insertion into bag.

(5) The waterproof barrier material should conform to the shape of the container.

(6) Markings are applied to the waterproof

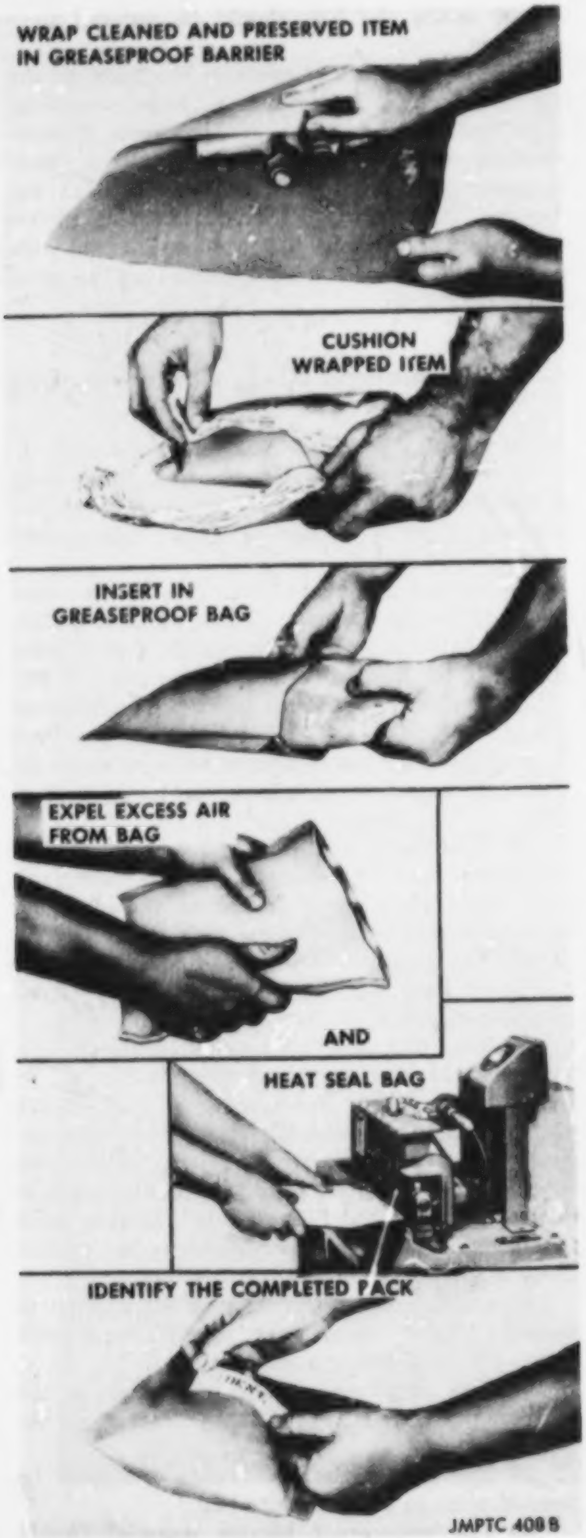

WRAP CLEANED AND PRESERVED ITEM IN GREASEPROOF BARRIER
CUSHION WRAPPED ITEM
INSERT IN GREASEPROOF BAG
EXPEL EXCESS AIR FROM BAG
AND
HEAT SEAL BAG
IDENTIFY THE COMPLETED PACK
JMPTC 408 B

Figure 3-36. Application of submethod IC-1.

barrier and to the overwrap or outer container, when one is used to protect the barrier material (table 3-11 and para 3-46).

3-20. Submethod IC-3, Waterproof Bag, Sealed

a. Materials Needed for Submethod IC-3.

(1) Cushioning material should be selected in accordance with the requirements in paragraph 3-5*d*. Only clean dry, noncorrosive cushioning material should be used.

(2) The waterproofing shall conform to MIL-B-117, Types I, II or III, Class A, B, Style 1, 2, or 3. Also bags in accordance with MIL-B-22020 may be used as limited by MIL-I-8574.

(3) Uncoated metallic items should be wrapped and cushioned with non-corrosive materials meeting the requirements of Test Method 3005 of Federal Test Method Standard 101. Examples of these materials are MIL-P-17667, MIL-P-130 and UU-P-553, Type II. Coated items should be wrapped with greaseproof barrier material conforming to Specification MIL-B-121, Grade A, QQ-A-1876 or MIL-B-22191, Type II.

b. How To Apply Submethod IC-3 (fig 3-38).

(1) Cushioning material is applied to protect fragile items and to cushion the bag against sharp or protuding edges of the item.

(2) The air volume inside the bag should be reduced to a minimum by conforming the bag closely to the item. The bag is then sealed in such a manner that it will pass the seal test (para 3-40).

(3) Identification consists of lithographing, embossing, hand stamping, roller coating, or applying a paper label properly marked to the exterior of the bag. Marking will be also be applied to an outer container, if used (tables 3-11 and para 3-46).

3-21. Submethod IC-4, Rigid Container Other Than All-Metal, Sealed

a. Materials Needed for Submethod IC-4.

(1) Greaseproof barrier material should conform to Specification MIL-B-121, Grade A; MIL-F-22191,

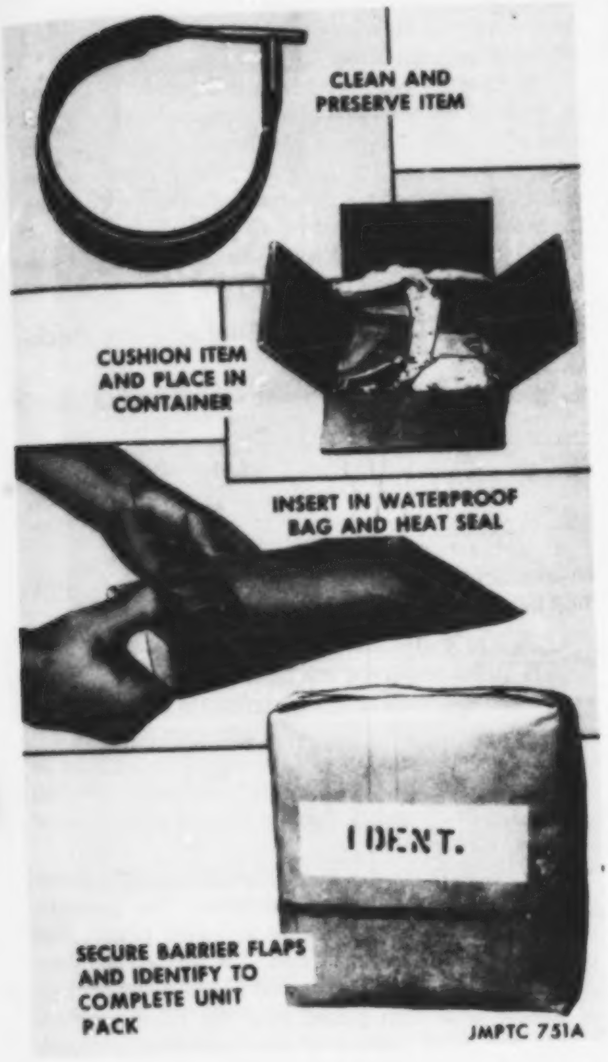

CLEAN AND PRESERVE ITEM
CUSHION ITEM AND PLACE IN CONTAINER
INSERT IN WATERPROOF BAG AND HEAT SEAL
IDENT.
SECURE BARRIER FLAPS AND IDENTIFY TO COMPLETE UNIT PACK
JMPTC 751A

Figure 3-37. Application of submethod IC-2.

Type II; or QQ-A-1876. Because of its reaction to certain metals, QQ-A-1876 materials should be used with caution (para 3-7*d*). A noncorrosive barrier, when required, is used as the initial wrap on items not coated with a preservative.

(2) Cushioning materials should be selected in accordance with the requirements in paragraph 3-5*d*. Only dry, noncorrosive cushioning materials should be used.

(3) The fiber can should conform to Specification MIL-C-3955, grade B, Type I or II, style and class, as applicable.

(4) Tape used for closure of Type II cans should conform to Specification MIL-T-43036.

(5) When a greaseproof liner is required, for the container, MIL-L-45973 liner material, greaseproof shall be used.

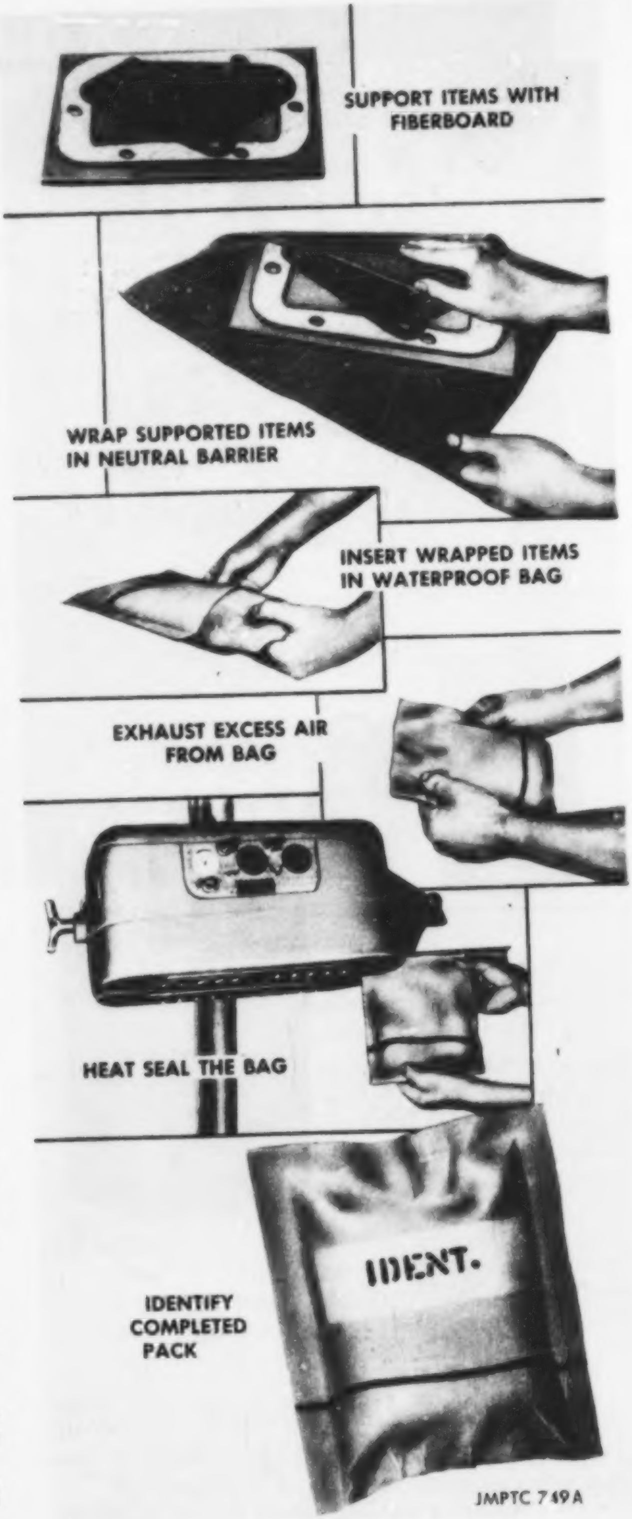

SUPPORT ITEMS WITH FIBERBOARD
WRAP SUPPORTED ITEMS IN NEUTRAL BARRIER
INSERT WRAPPED ITEMS IN WATERPROOF BAG
EXHAUST EXCESS AIR FROM BAG
HEAT SEAL THE BAG
IDENT.
IDENTIFY COMPLETED PACK
JMPTC 749A

Figure 3-38. Application of submethod IC-3.

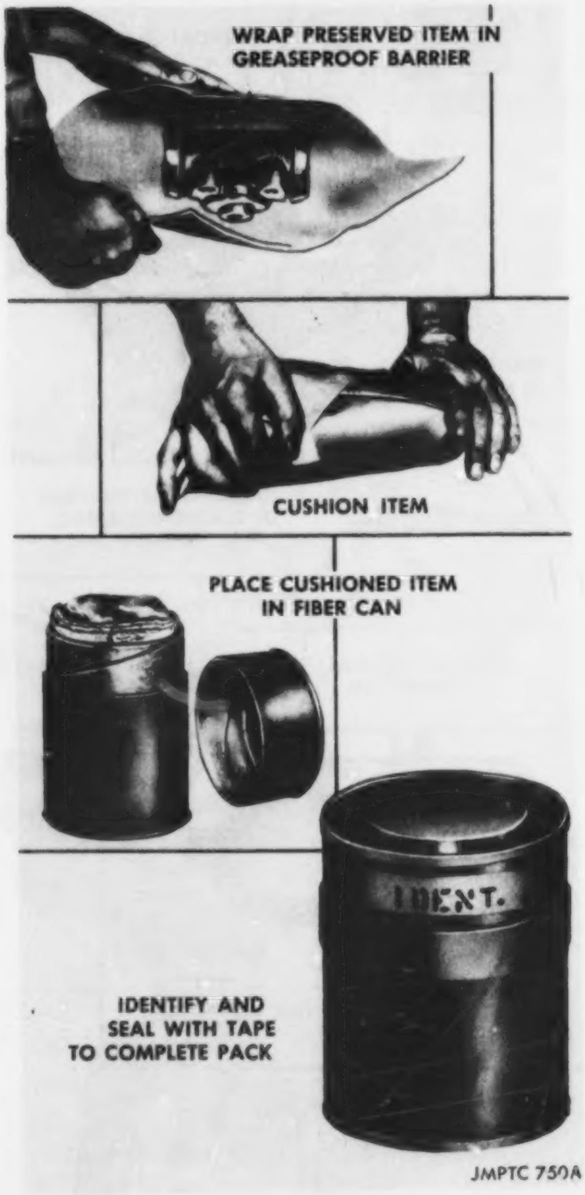

WRAP PRESERVED ITEM IN GREASEPROOF BARRIER
CUSHION ITEM
PLACE CUSHIONED ITEM IN FIBER CAN
IDENT.
IDENTIFY AND SEAL WITH TAPE TO COMPLETE PACK
JMPTC 750A

Figure 3-39. Application of submethod IC-4.

b. How To Apply Submethod IC-4 (fig 3-39).

(1) Material in contact with uncoated items should meet the requirements of Test Method 3005 of Federal Test Method Standard 101. Material in contact with a preservative film must be greaseproof.

(2) Cushioning material should be used to protect fragile items and control movement within the container.

(3) The wrapped and cushioned item should conform closely to the shape of the container to include a minimum amount of air.

(4) Closure of the containers is made by sealing the joint of the top and bottom portions of the Type II cans with tape. The tape should be at least 1¼ inch wide, and at least 1⅓ times the circumference of the can in length. Special machines are used for crimping the metal top to the body of the Type I cans.

(5) Identification should be applied on the container (table 3-11 and para 3-46).

3-22. Submethod IC-7, Blister Pack Package

Single or multiple compartment individually sealed.

a. Materials Needed for Submethod IC-7.

(1) Cellulose acetate butyrate, cellulose acetate, or cellulose proprionate, according to thickness specified, will be used in the construction of the multiple compartments.

(2) Other plastic films may be used when specified.

b. How to Apply Submethod IC-7 (fig 3-40).

(1) Items preserved in a light oil-type preservative are placed in individual compartments of a multiple-compartment container.

(2) The compartment size of the container shall be appropriate for the item. The depth of each individual compartment should be greater than the thickness of the contained item.

(3) Multiple-compartment containers are fabricated on vacuum forming machines. The compartments are formed by drawing a heated plastic film over a mold by vacuum suction. The formed compartments then receive the preserved items. Another sheet of plastic is in turn placed over the filled compartments and final sealing of the individual compartments is accomplished by an electronic sealing machine. The multiple compartment plastic containers shall be furnished with either perforations or tear lines to enable separation without damage to seals.

(4) Each compartment shall be considered the unit pack and shall be marked.

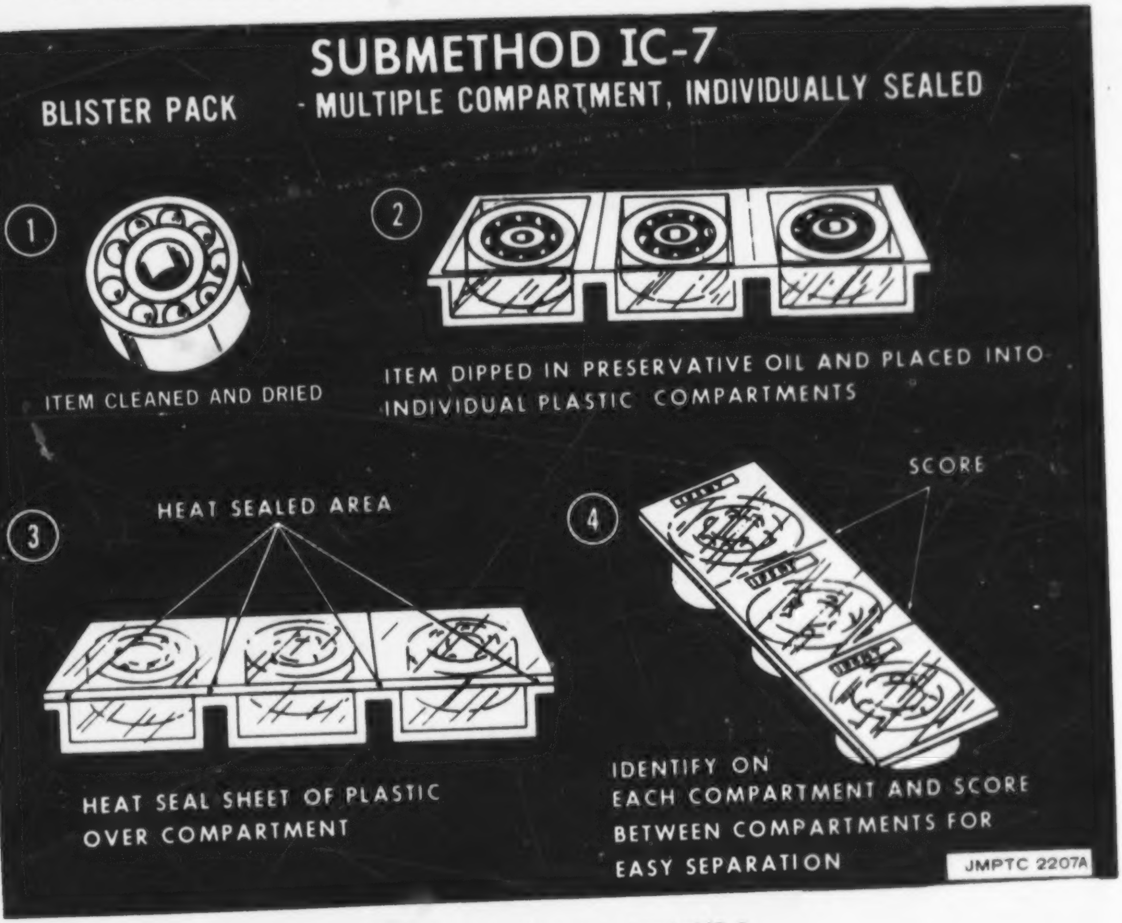
(5) The completed pack shall not leak when tested in accordance with the vacuum chamber-technique (para 3-39c).

3-23. Submethod IC-9 Skin Package-Greaseproof, Waterproof, Vacuum Formed

a. Materials Needed for Submethod IC-9. Cellulose acetate, cellulose acetate butyrate, or cellulose proprionate will be used in the construction of a vacuum formed skin package.

b. How To Apply Submethod IC-9 (fig 3-41).

(1) The material shall be of sufficient thickness to


SUBMETHOD IC-7
BLISTER PACK - MULTIPLE COMPARTMENT, INDIVIDUALLY SEALED
1
ITEM CLEANED AND DRIED
2
ITEM DIPPED IN PRESERVATIVE OIL AND PLACED INTO INDIVIDUAL PLASTIC COMPARTMENTS
3
HEAT SEALED AREA
HEAT SEAL SHEET OF PLASTIC OVER COMPARTMENT
4
SCORE
IDENTIFY ON EACH COMPARTMENT AND SCORE BETWEEN COMPARTMENTS FOR EASY SEPARATION
JMPTC 2207A

Figured 3-40. Application of submethod IC-7.

contain the item, permit identification of item marking, and permit visual examination of the exterior surfaces of the item.

(2) The transparent plastic sheet will be vacuum formed over the item. After draping the closure sheets, the transparent plastic pack will be sealed.

(3) The completed package shall not leak when tested in accordance with the submersion (or immersion) technique (para 3-39*f*) after rough handling (para 3-42) when packed as for shipment.

3-24. Submethod IC-10-Skin Package-Waterproof, Vacuum Former (fig 3-41)

a. Materials Needed for Submethod IC-10. Any plastic film capable of being vacuum formed into a waterproof pack may be used.

b. How To Apply Submethod IC-10. The same techniques are used as for submethod IC-9 (para 3-23*b*).

c. The completed pack shall not leak when tested in accordance with the vacuum chamber technique (para 3-39c).

3-25. Method II, Water-Vaporproof Barrier With Desiccant (With Control Preservative When Required

a. Concept of Method II. Method II is accomplished by enclosing the clean, dry and preserved (when required) item or assembly, with the proper amount of activated desiccant, within a water-vaporproof barrier. Packs will be designed and constructed to pass the tests listed under each submethod in table 3-11.

b. When to Apply Method II. Method II preservation is used for items of a highly critical nature which require the highest degree of protection from damage by the effects of water vapor. It is applicable to mechanical or electrical items including assemblies with functional components which, because of their nature, cannot be treated with a preservative. A preservative, when used for additional protection, must be such as to permit the operation of the equipment without removal of the preservative. This method is *not* used on any item where the withdrawal of moisture would cause damage to the item. The maximum load that can

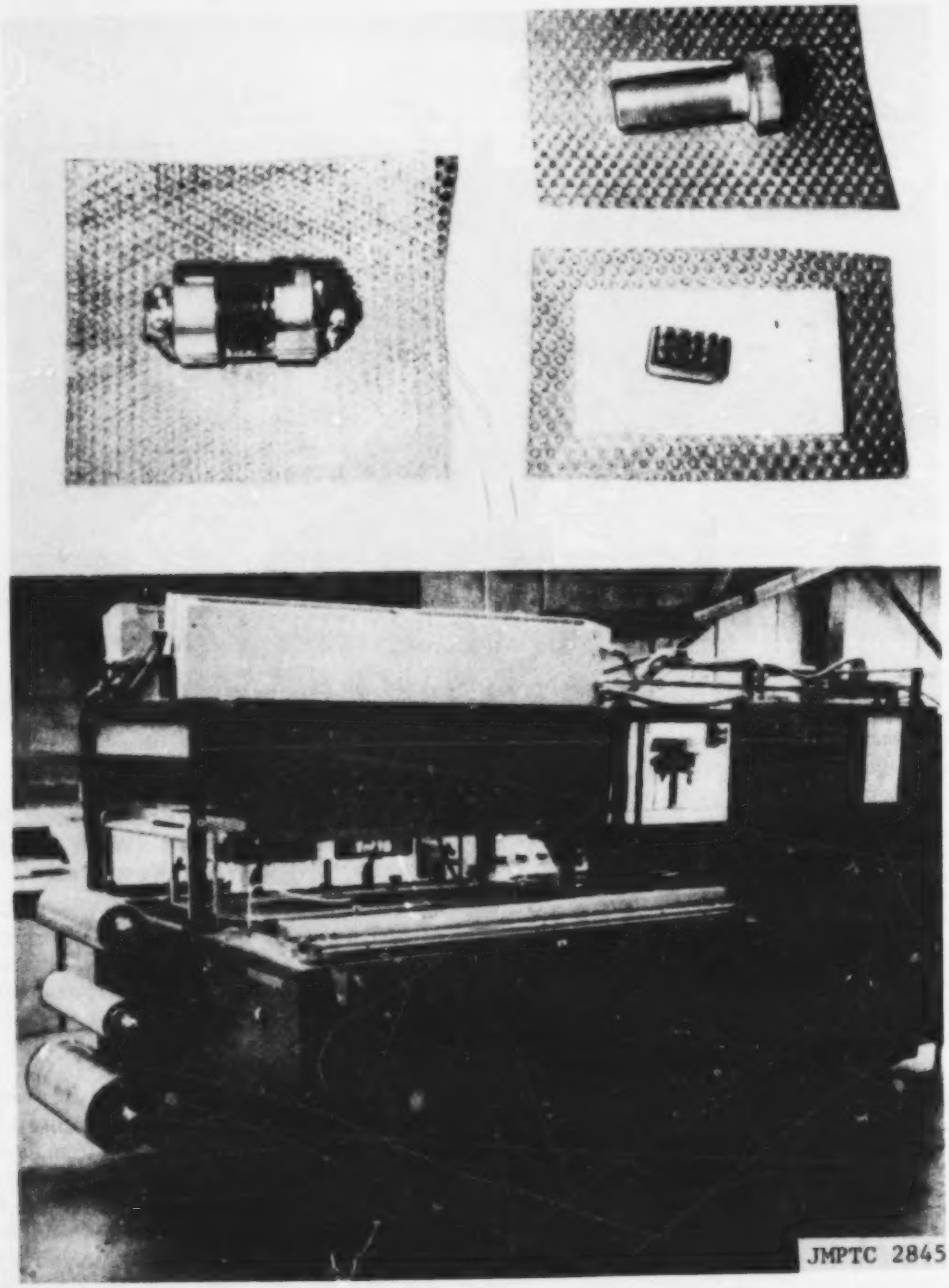


Figure 3-41. Application of submethod IC-9 & IC-10.

be carried by any one bag is established in MIL-B-117 and MIL-E-6060.

c. *How Method II Protects.* Since experience and tests have proven that the corrosion of a clean item will not normally occur when a relative humidity of 30 percent is maintained within a barrier, complete protection for items packed by method II is afforded by keeping the relative humidity below this level, usually 20 percent relative humidity is established in order that small leaks which inadvertently occur will not raise the internal relative humidity higher than 30 percent during a normal storage period of 18 months to 2 years. The effectiveness of method II preservation rests upon five factors. These factors are—

(1) The volume of enclosed space.

(2) The surface area of the enclosing barrier.

(3) The water vapor transmission rate of the enclosing barrier.

(4) The moisture content of item and dunnage at the time of preservation.

(5) The quantity of desiccant used.

d. *Relative Humidity.* Relative humidity is the ratio of the quanity of water vapor actually present in the air to the greatest amount the air can hold at a given temperature. Once the quantity of water that must be removed to effect and maintain the required low relative humidity has been established, the amount of desiccant determined in accordance with table 3-5 must be provided. Accordingly, the volume should be held to a minimum consistent with other packaging requirements. The various sources of water within a pack are—

(1) The water vapor in the air enclosed by the barrier.

(2) The water vapor content of the item and all dunnage enclosed within the barrier.

(3) The water vapor transmitted through the barrier after closure. Sufficient desiccant must be provided to absorb water initially from the first two sources for the period of the anticipated life of the pack. Where the quantity of desiccant established by calculations is in excess of that permitted by limitations of space and weight, either the pack must be redesigned to provide for less surface area of the barrier, or a barrier with a lower water vapor transmission rate must be used.

e. *Desiccants (Activated).* (para 3-4e)

f. *Humidity Indicators.* (para 3-4f)

g. *Inspection Windows.* (para 3-4g)

h. *General Procedure for method II.* Method II preservation must be accomplished in one continuous operation in the shortest possible time. The item must be cleaned, dried and preserved as required prior to packing. When wood or other hygroscopic materials, tending to release moisture, acids, or other corrosive products, have to be used, direct contact shall be prevented by applying wrappings of Grade A, MIL-B-121, MIL-B-13239, or QQ-A-1876 over contact points. Where practicable, the item must be supported on noncritical surfaces. There are six submethods for application of basic method II preservation—

(1) *Submethod IIa.* Floating bag.

(2) *Submethod IIb.* Container, barrier, container.

(3) *Submethod IIc.* Container item, bag.

(4) *Submethod IId.* Rigid metal container, sealed.

(5) *Submethod IIe.* Container, barrier.

(6) *Submethod IIf.* Rigid container, other than all-metal, sealed.

As it often becomes necessary to open a bag fabricated of flexible barrier to inspect the contents or to renew the desiccant, it is required to leave sufficient material at the top of the bag to permit resealing at least twice. The extra material required ordinarily amounts to about 4 inches.

3-26. Submethod IIa, Floating Bag, Sealed

a. Bag shall conform to MIL-B-117, Type I or II, Class E, F or G. Style 1 or 2. For larger bags than permitted by MIL-B-117, bags should be made in accordance with MIL-E-6060. For tests applicable to submethod IIa, see table 3-11. As specified, a window conforming to para 3-4*g* and fig 3-42 is provided in the barrier in such a manner as to make the humidity indicator visible. An inspection port with replaceable cover is provided in the outer container through which the humidity indicator is visible. The floating bag is made with gasketed holes through which bolts pass to secure the item to a supporting member of the box or crate (fig 3-42). Once the gaskets have been cemented in position, the tension on the nut must be sufficient to effect an airtight seal around the attaching bolt. Prior to forming the bag around the item, cushioning is used to cover all sharp edges and corners of the item. Cushioning can be attached to the item by taping, typing, or other suitable means.

b. Upon completion of the cushioning operation, the desiccant and humidity indicator are applied. The bag(s) of desiccant are attached to the item by tying with a cord, taping, or wiring. Care should be taken to prevent desiccant bags from touching critical surfaces of the item.

c. The floating bag is formed by drawing the barrier around the item and sealing the vertical end seams. Following this operation, the top can be sealed except for an opening which is left for insertion of a vacuum spout (fig 3-42). In withdrawing the air from the partially closed bag, the spout is inserted in the opening which is left for insertion of a vacuum spout (fig 3-42).

In withdrawing the air from the partially closed bag, the spout is inserted in the opening and the barrier material drawn tightly around the spout by hand. Complete withdrawal of the air from the bag is not recommended. A bag which fits too tightly over the item is more susceptible to puncture than one loosely drawn. The remaining opening is sealed. The final closing operation should be performed in a manner which will not permit an appreciable amount of air to reenter the bag. The "ears" or "flaps" of the bag are folded over and taped in place as shown in figure 3-42.

d. To prevent premature opening, the date of preservation is included as part of the identification markings (para 3-46). If space for a method II label (fig 3-43) or stamp is not available, the words "METHOD II PACK—DO NOT OPEN UNTIL READY FOR USE," in as large letters as possible, will be placed below the last line of the identification markings.

CAUTION

The selection and application of the adhesives used to affix the gaskets to Type I, MIL-B-22191 material, should be in accordance with the recommendations of the manufacturer of the plastic film. Fluorocarbon films must be pretreated to assure adhesive bonding.

3-27. Submethod IIb, Container, Bag, Sealed, Container

a. Submethod IIb consists of sealing a container in a water-vaporproof bag which in turn is placed in another container (fig 3-43). The bag shall conform to MIL-B-117, Type I, II or III, Class E, F or G, Style 1, 2, or 3. For larger bags than permitted by MIL-B-117, bags should be made in accordance with MIL-E-6060. Care must be taken to insure that the item is properly cushioned in the inner container. All corners of the fiberboard or chipboard inner container must be rounded or blunted and metal stitches inside the secondary fiberboard container must be covered with tape or other materials as a protection to the barrier against rupture.

b. When an item is provided with a rigid inclosure, which affords protection equivalent to a carton or a box, such as an instrument box or a carrying case, the rigid inclosure may be used as the inner container. When this is done, sufficient room must exist within the enclosure for proper placement and distribution of the desiccant; the item must be properly secured within the inclosure; and the inclosure must be properly wrapped or cushioned to prevent damage to the barrier bag, and properly locked or taped to prevent spilling of the contents within the bag.

c. For tests applicable to submethod IIb, see table 3-11 and paragraph 3-36. In all cases where desiccant is used, the moisture content of the dunnage, including the inner container, must be considered in calculating the amount of desiccant required. When fiberboard containers are specified for the exterior, they shall conform to weather-resistant class or grade of PPP-B-636 or PPP-B-640. When wood-cleated plywood or nailed wood boxes are used as the outer container and the boxes shall be lined with heavy kraft paper to prevent chafing of the water-vaporproof barrier. Closure of the container shall not damage the barrier material.

d. Identification markings are required on the water-vaporproof barrier and the outer container. For method II label requirements, see paragraph 3-26*d*. In closing the inner container within the water-vaporproof barrier, it is necessary to exhaust as much of the air from the envelope as is practicable.

3-28. Submethod IIc, Cushioned Item, Bag

a. Bag shall conform to MIL-B-117 Type I, II, or III, Class E, F or G, Style 1, 2 or 3. Bags in accordance with MIL-E-6060 shall be used for items too large for enclosure in MIL-B-117. Cellulose wadding, Specification PPP-C-843, grade A barrier material, Specification MIL-B-121, felt, etc., are used for cushioning purposes. Care must be taken to avoid sharp edges of the item from puncturing the water-vaporproof bag.

b. Just prior to sealing the bag, as much air as practicable should be removed. On relatively small bags, this can be done by flattening the bag between the hands. While the bag is still in the flat condition, sealing is effected, as shown in figure 3-45. Each bag used in submethod IIc requires individual identification (table 3-11). For method II label requirements, see paragraph 3-26*d*. To determine the amount of desiccant needed, Formula 1 of table 3-8 should be used.

3-29. Submethod IId, Rigid Metal Container, Sealed

a. Any rigid metal container with machined seamed closure or reusable gasketed closure may be used unless a particular type has been specified in the contract or order. The containers generally used fall into the three following classifications:

(1) The hermetically sealed metal cans—single trip containers.

(2) The interior metal shipping drums—reusable.

(3) The metal shipping and storage containers—reusable.

b. Tests applicable to submethod IId packages are shown in table 3-11 and treated in paragraph 3-36.

c. Proper cushioning of the item is of prime importance when packing by this submethod. The same cushioning materials used for other methods and sub-

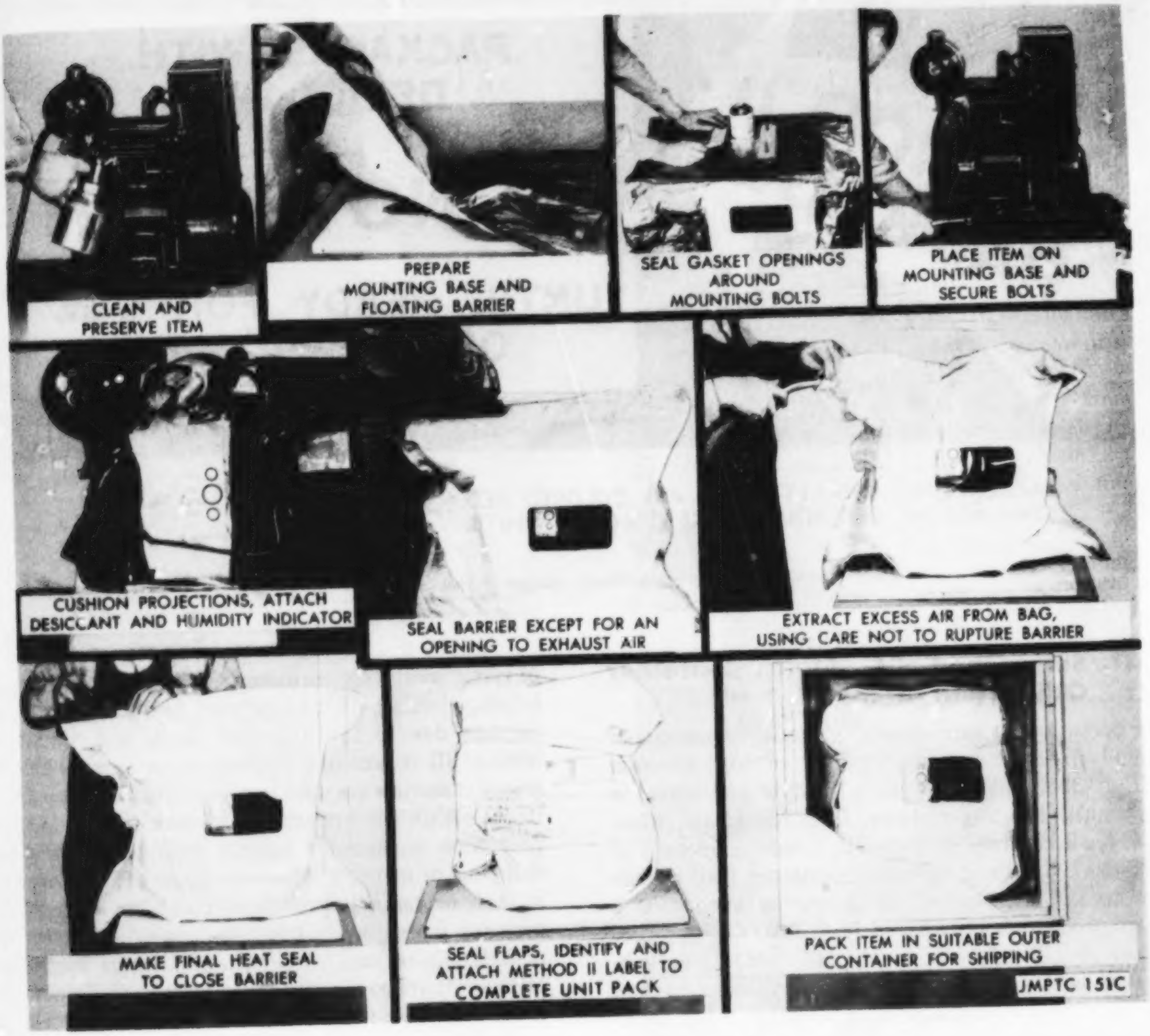
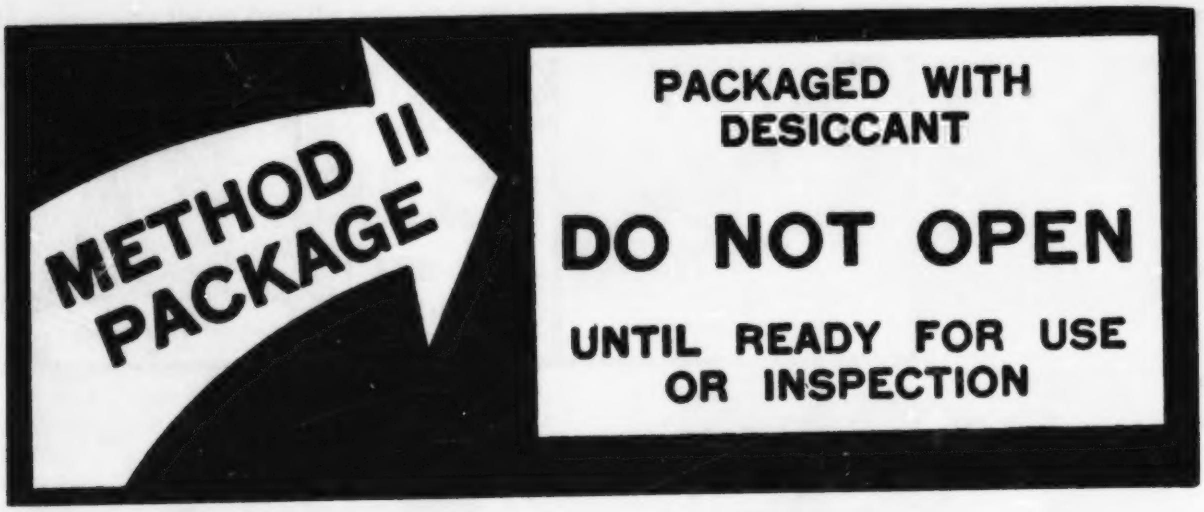

CLEAN AND PRESERVE ITEM
PREPARE MOUNTING BASE AND FLOATING BARRIER
SEAL GASKET OPENINGS AROUND MOUNTING BOLTS
PLACE ITEM ON MOUNTING BASE AND SECURE BOLTS
CUSHION PROJECTIONS, ATTACH DESICCANT AND HUMIDITY INDICATOR
SEAL BARRIER EXCEPT FOR AN OPENING TO EXHAUST AIR
EXTRACT EXCESS AIR FROM BAG, USING CARE NOT TO RUPTURE BARRIER
MAKE FINAL HEAT SEAL TO CLOSE BARRIER
SEAL FLAPS, IDENTIFY AND ATTACH METHOD II LABEL TO COMPLETE UNIT PACK
PACK ITEM IN SUITABLE OUTER CONTAINER FOR SHIPPING
JMPTC 151C

Figure 3-42. Application of submethod IIa.

methods are acceptable here, but care should be taken to insure sufficient impact protection. This is necessary because the metal container does not possess the inherent cushioning qualities of fiberboard or wooden containers. The item is wrapped in grade A of MIL-B-121 or a noncorrosive barrier prior to cushioning. Since the metal container has a zero water vapor transmission rate, the quantity of desiccant required to preserve an item is that needed to reduce the internal relative humidity to a safe condition. Therefore, Formula II of table 3-8 which is designed to accomplish this under practically all conditions, shall be used. The interval between opening the desiccant storage container and the final sealing of the unit container, should be kept as short as possible. The steps for accomplishing a submethod IId pack are shown in figure 3-46.

3-30. Submethod IIe, Container, Bag, Sealed

This submethod is effected in the same manner as submethod IIb, except that the outer container is omitted (fig 3-47). It is used predominantly when a number of packages of this type can be inclosed in an intermediate or shipping container. In no instance is the container-barrier pack to be shipped without further outside protection to the barrier material. However, when an item so preserved is to be transported by air, it is permissible to overwrap the pack with a sealed kraft envelope or bag.



NOTE. BACKGROUND AND LETTERING ARE COLORED RED.
THE ARROW AND SQUARE ARE COLORED WHITE.

JMPTC 766

Figure 3-43. Method II label.

3-31. Submethod IIf, Rigid Container Other Than All-Metal, Sealed

For contents not exceeding 20 pounds, the container should meet the requirements of Specification MIL-C-3955, Grade B, Type I, style and class, as applicable. For larger items, fiber containers, when used shall conform to Type III, Grade A, class 2 of PPP-D-723. Use of any other container shall be subject to the approval of the procuring agency. If a greaseproof liner is required for a MIL-C-3955 container it will conform to MIL-L-45973. This submethod is effected in the same manner as submethod IA-13, except that desiccant is used (fig 3-48). Leakage tests (table 3-11 and para 3-39) prescribed for submethod IIf are designed to test the closure of the container and should not be used to establish the quality of the container.

3-32. Method III, Packaged for Mechanical and Physical Protection Only

a. Concept of Method III. Method III provides mechanical and physical protection only and does not afford any protection against the entry of water, water-vapor, fumes, atmospheric gases, or the growth of microorganisms. Protection against climatic and atmospheric conditions is not provided because the items packed by Method III are, by the characteristics of their construction and composition, immune to such conditions.

b. When To Apply Method III. Mechanical and physical protection is provided by Method III by means of tying, wrapping, cushioning, blocking, bracing, palletizing, boxing, etc., to prevent free movement and damage due to the effect of shock and vibration. Method III is accomplished whenever wraps or cushioning materials are used to give physical protection to items within their containers; whenever any kind of protection is provided against scratching, abrading, chipping, or marring; whenever items are made secure in their containers by blocking and bracing; or whenever any measures are taken to counteract the effects of falls, blows, and carrier hazards. Items packed by Method III are generally those of a chemically noncritical nature, made of corrosion-resistant metals or inert nonmetals such as crockery, ceramics or nonoptical glass; or items rendered corrosion- or deterioration-resistant by the application of metal platings, paint, prime coatings, plastic coatings, or similar treatments or finishes.

c. Materials Needed for Method III. There are many materials used for making Method III packs, and these will vary with the finish and fragility of the items being packed. Only a brief mention can be made of some of the most common ties, wraps, cushioning, blocking and bracing materials, and containers used.

(1) *Ties and binders.* Materials suitable for tying, binding, baling, or bundling will vary with the weight and size of the items. Bursting strength may vary from 3 pounds for a two-ply cotton wrapping twine up to several tons for heavy gauge steel wire. Examples of materials used for tying and bundling are twine, cotton, wrapping (T-T-871); and twine, jute (T-T-911).

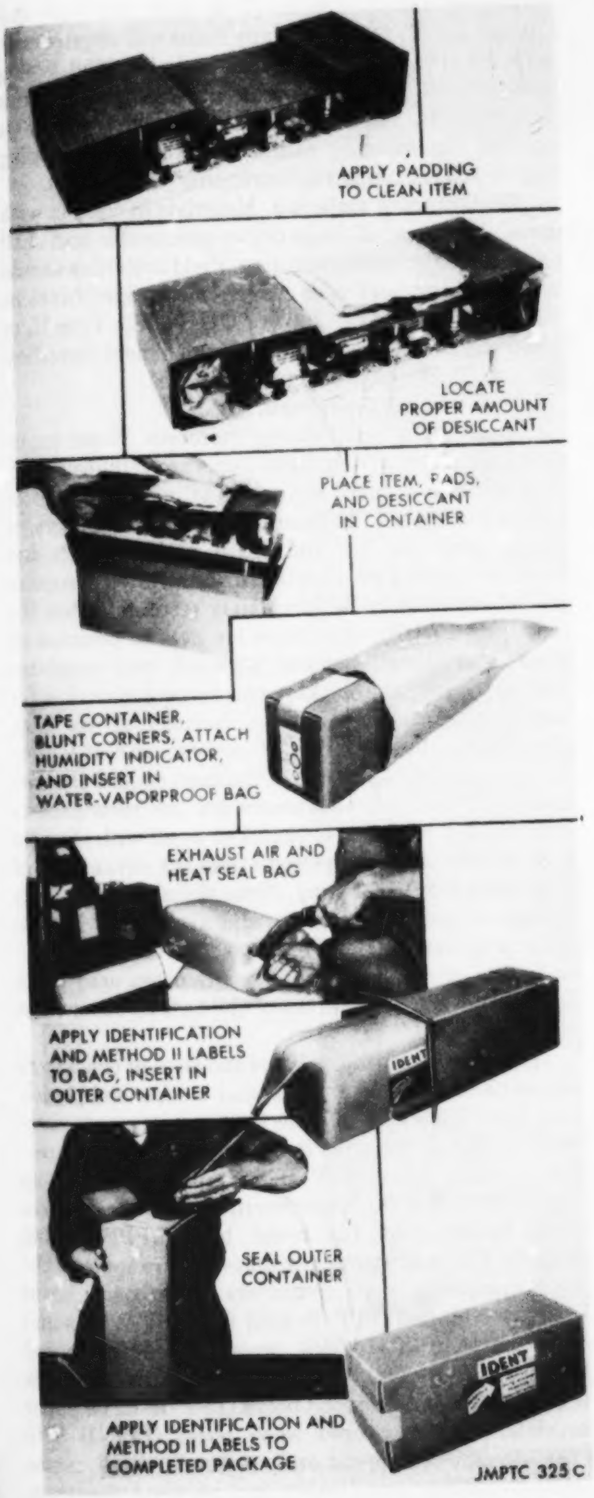

APPLY PADDING TO CLEAN ITEM
LOCATE PROPER AMOUNT OF DESICCANT
PLACE ITEM, PADS, AND DESICCANT IN CONTAINER
TAPE CONTAINER, BLUNT CORNERS, ATTACH HUMIDITY INDICATOR, AND INSERT IN WATER-VAPORPROOF BAG
EXHAUST AIR AND HEAT SEAL BAG
APPLY IDENTIFICATION AND METHOD II LABELS TO BAG, INSERT IN OUTER CONTAINER
IDENT
SEAL OUTER CONTAINER
IDENT
APPLY IDENTIFICATION AND METHOD II LABELS TO COMPLETED PACKAGE
JMPTC 325 C

Figure 3-44. Application of submethod IIb.

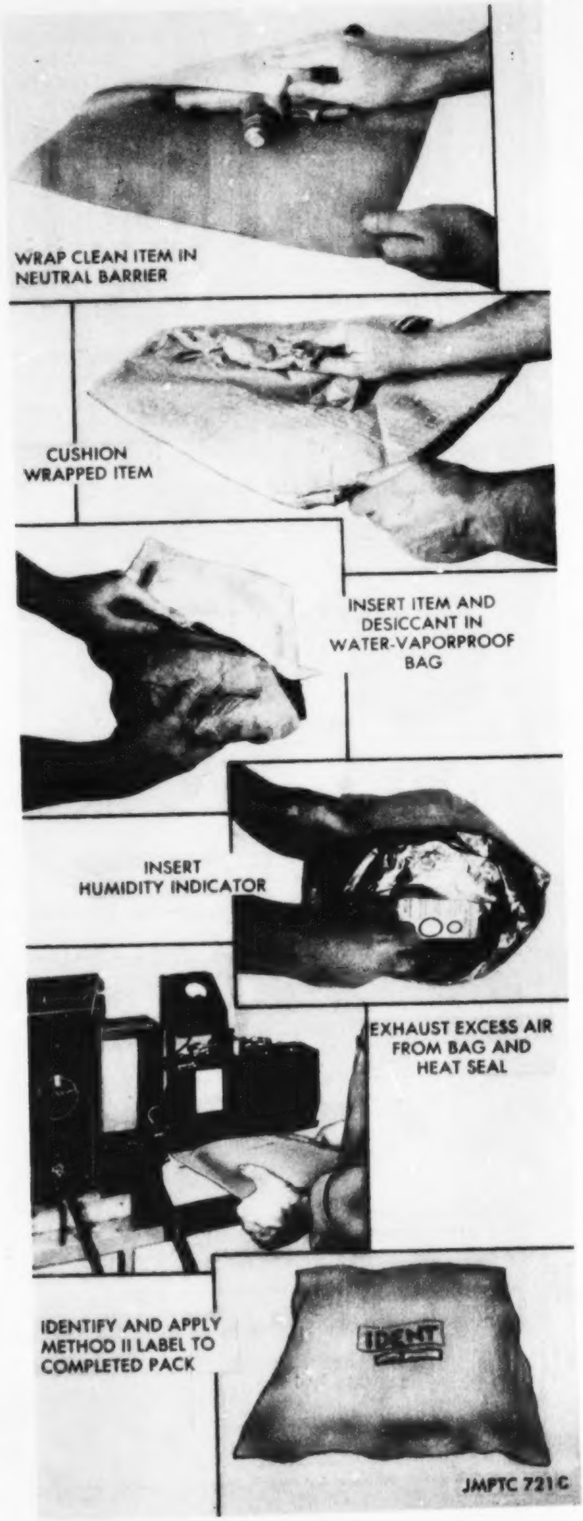

WRAP CLEAN ITEM IN NEUTRAL BARRIER
CUSHION WRAPPED ITEM
INSERT ITEM AND DESICCANT IN WATER-VAPORPROOF BAG
INSERT HUMIDITY INDICATOR
EXHAUST EXCESS AIR FROM BAG AND HEAT SEAL
IDENTIFY AND APPLY METHOD II LABEL TO COMPLETED PACK
IDENT
JMPTC 721 C

Figure 3-45. Application of submethod IIc.

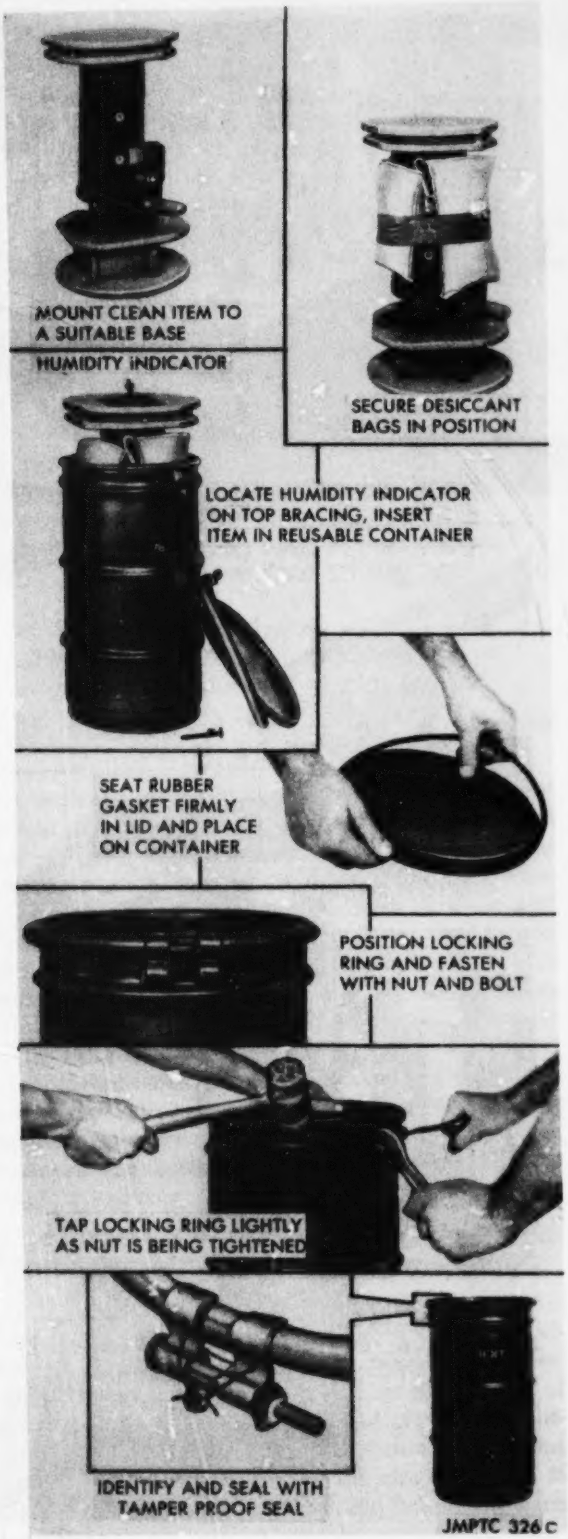

MOUNT CLEAN ITEM TO A SUITABLE BASE
HUMIDITY INDICATOR
SECURE DESICCANT BAGS IN POSITION
LOCATE HUMIDITY INDICATOR ON TOP BRACING, INSERT ITEM IN REUSABLE CONTAINER
SEAT RUBBER GASKET FIRMLY IN LID AND PLACE ON CONTAINER
POSITION LOCKING RING AND FASTEN WITH NUT AND BOLT
TAP LOCKING RING LIGHTLY AS NUT IS BEING TIGHTENED
IDENTIFY AND SEAL WITH TAMPER PROOF SEAL
JMPTC 326 C

Figure 3-46. Application of submethod IId.

For heavier items, suitable ropes and cordage may include rope, yarn and twine (T-R-650); and rope, manila and sisal (T-R-605). Many items will require even more durable ties of wire such as baling and typing wire (QQ-W-311), or corrosion-resisting steel wire (QQ-W-423). Many packs may be held together as bundled materials by means of flat steel strapping (QQ-S-781) or round steel strapping (QQ-S-790).

(2) *Wrapping materials.* Materials in contact with metal surfaces shall be as dry as practicable and shall not cause or promote corrosion. Field activities should use wrapping materials which meet Specifications MIL-P-130, MIL-P-17667 or UU-P-553, Type II, or metallic surfaces, and materials which meet Specification UU-P-268 on nonmetallic surfaces.

(3) *Cushioning materials.* (fig 3-5)

(4) *Blocking and bracing materials.* Some materials used for relatively light items are cellulosic wadding made into pads; various bundlings of burlap or cotton; corrugated fiberboard made into cells, trays, or pleated pads (fig 3-9 and 3-10); and flat pads and liners of corrugated fiberboard. Large items require special attention to be adequately secured within the container. Usually such items are held in position by blocks and braces. Lumber, plywood, and metal are used as the primary blocking and bracing materials for large, dense items. Lumber, because of its high strength-weight ratio, ease of cutting, ease of fastening, and availability, is one of the most commonly used materials. Its chief weaknesses are low resistance to splitting and tendency to shrink or swell with changes in moisture content. Plywood offers the advantages of high resistance to splitting, dimensional stability with changes in moisture content, and availability in relatively wide panels. Metal brackets, frames, tie rods, U- or J-bolts, and metal strappings are often used to tie down or anchor heavy items to the base of other faces of the container.

(5) *Containers.* Many types and sizes of containers are employed to give physical and mechanical protection. Some common examples for small items are cushioned shipping sacks (PPP-S-30) (para 3-4c), paperboard folding boxes (PPP-B-566), paperboard set-up boxes (PPP-B-676), paperboard metalstayed boxes (PPP-B-665), and fiberboard boxes (PPP-B-636) (chap 5). For large items, the following are some of the most commonly used containers: Fiberboard boxes (PPP-B-636) and (PPP-B-640) (chap 5); Wirebound wood boxes (PPP-B-585), wood-cleated fiberboard boxes (PPP-B-591), wood-cleated plywood boxes (PPP-B-601), nailed wood boxes (PPP-B-621), paper overlaid, veneer, cleated wood boxes (PPP-B-576) (TM 38-230-2); open and covered wood crates (MIL-C-52950), and lumber and plywood sheathed, wood crates (MIL-C-104) (TM 38-230-2).

(6) *Tapes.* Tapes are used for securing items to-

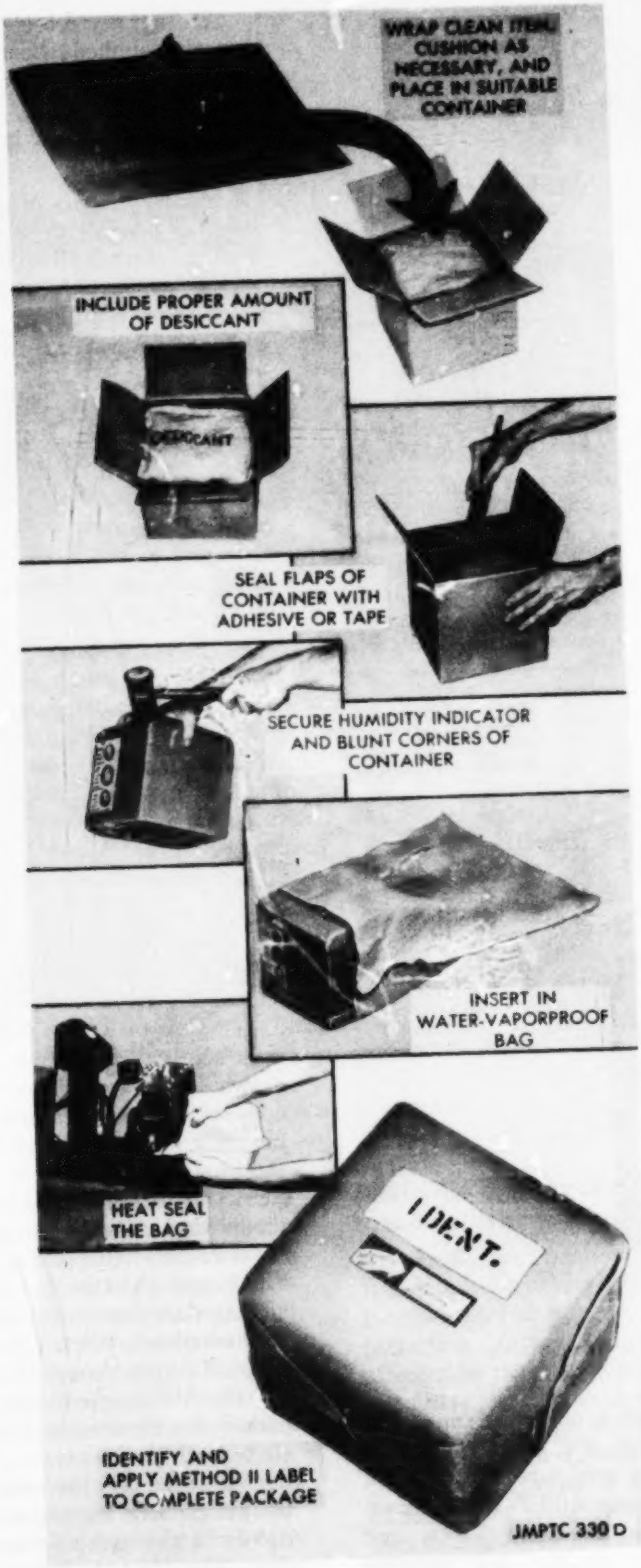

WRAP CLEAN ITEM, CUSHION AS NECESSARY, AND PLACE IN SUITABLE CONTAINER
INCLUDE PROPER AMOUNT OF DESICCANT
DESICCANT
SEAL FLAPS OF CONTAINER WITH ADHESIVE OR TAPE
SECURE HUMIDITY INDICATOR AND BLUNT CORNERS OF CONTAINER
INSERT IN WATER-VAPORPROOF BAG
HEAT SEAL THE BAG
IDENT.
IDENTIFY AND APPLY METHOD II LABEL TO COMPLETE PACKAGE
JMPTC 330 D

Figure 3-47. Application of Submethod IIe.

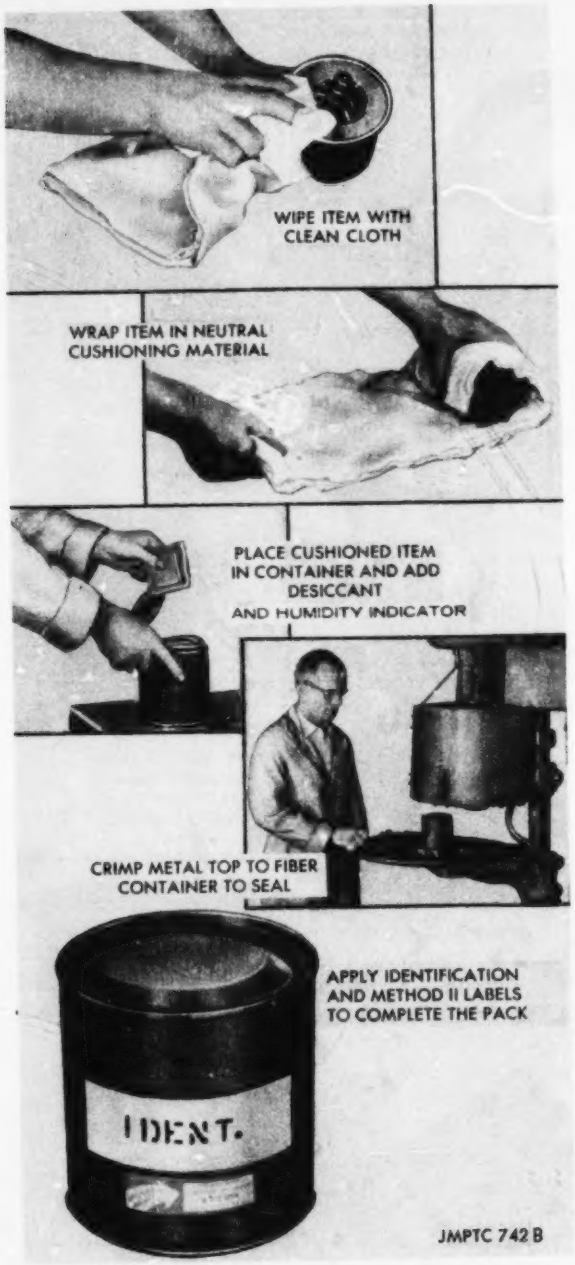

WIPE ITEM WITH CLEAN CLOTH
WRAP ITEM IN NEUTRAL CUSHIONING MATERIAL
PLACE CUSHIONED ITEM IN CONTAINER AND ADD DESICCANT AND HUMIDITY INDICATOR
CRIMP METAL TOP TO FIBER CONTAINER TO SEAL
APPLY IDENTIFICATION AND METHOD II LABELS TO COMPLETE THE PACK
IDENT.
JMPTC 742 B

Figure 3-48. Application of submethod IIf.

gether in bundles, rolls, or other units; and for closing or reinforcing cartons, boxes, and other containers. Among the most commonly used tapes are filament reinforced, pressure-sensitive tape (PPP-T-97); water-resistant pressure-sensitive tape (PPP-T-60); and gummed, paper, tape for sealing and securing (PPP-T-45) (para 3-4*i*).

(7) *Tags and labels.* To complete the final step in preparing Method III packages, identification must be made as prescribed in paragraph 3-46 and table 3-11. Shipping and stock tags (UU-T-81) or white, smooth finish, gummed paper labels (para 3-4*h*) are used for this purpose.

d. How To Apply Method III. It is neither practicable nor possible to present detailed information on all of the Method III applications. Several of the most common applications are illustrated in figure 3-49.

3-33. Thermoformed Packing

a. Definition. Thermoformed packaging is packaging which employs thermoplastics which may be drawn tightly against the item, as in skin packaging, or molded to the approximate configuration of the item, as in bubble packing, by heating the plastic to its softening point and draping it about the item or mold. Examples of the films used are flexible vinyls, acetates, butyrates, styrene, polyester films, and polyethylene (fig 3-50).

b. Thermoforming. The most common method of thermoformed packing is known as vacuum forming. This method employs a machine capable of performing two functions basic to the method, i.e., the creating of a vacuum and the application of heat to the transparent material used for the packing. In addition to the transparent film, there is usually employed a backing or mounting board. Figure 3-51 is an example of a typical machine used for developing vacuum formed packs.

c. Variations of Thermoforming. There are three variations of the thermoformed pack, the "skin" pack, the "blister" pack, and the "shrink" pack.

(1) *Skin pack.* The skin pack is so named because, as a result of the process, the transparent film is drawn tightly around the item being packed, forming a skintight protective covering. In forming this pack normally a backing board is used on which to mount the item and to which to heat seal the transparent film. This backing board from within a few inches of the heating unit in its forward position to an immediate proximity to the platen. In the uppermost position; heat is applied to the transparent film by drawing the heating unit over it. When the transparent film has been adequately heated, the clamping frame with the softened film is dropped to the lower position; bringing the film in direct contact with the item being packed. Simultaneously, a valve is opened allowing the air beneath the transparent film and surrounding the item to surge into the vacuum tank, thus permitting the atmospheric air pressure to force the film down tightly to the backing board and tightly around the item. When the film cools, it forms a sealed covering over the item.

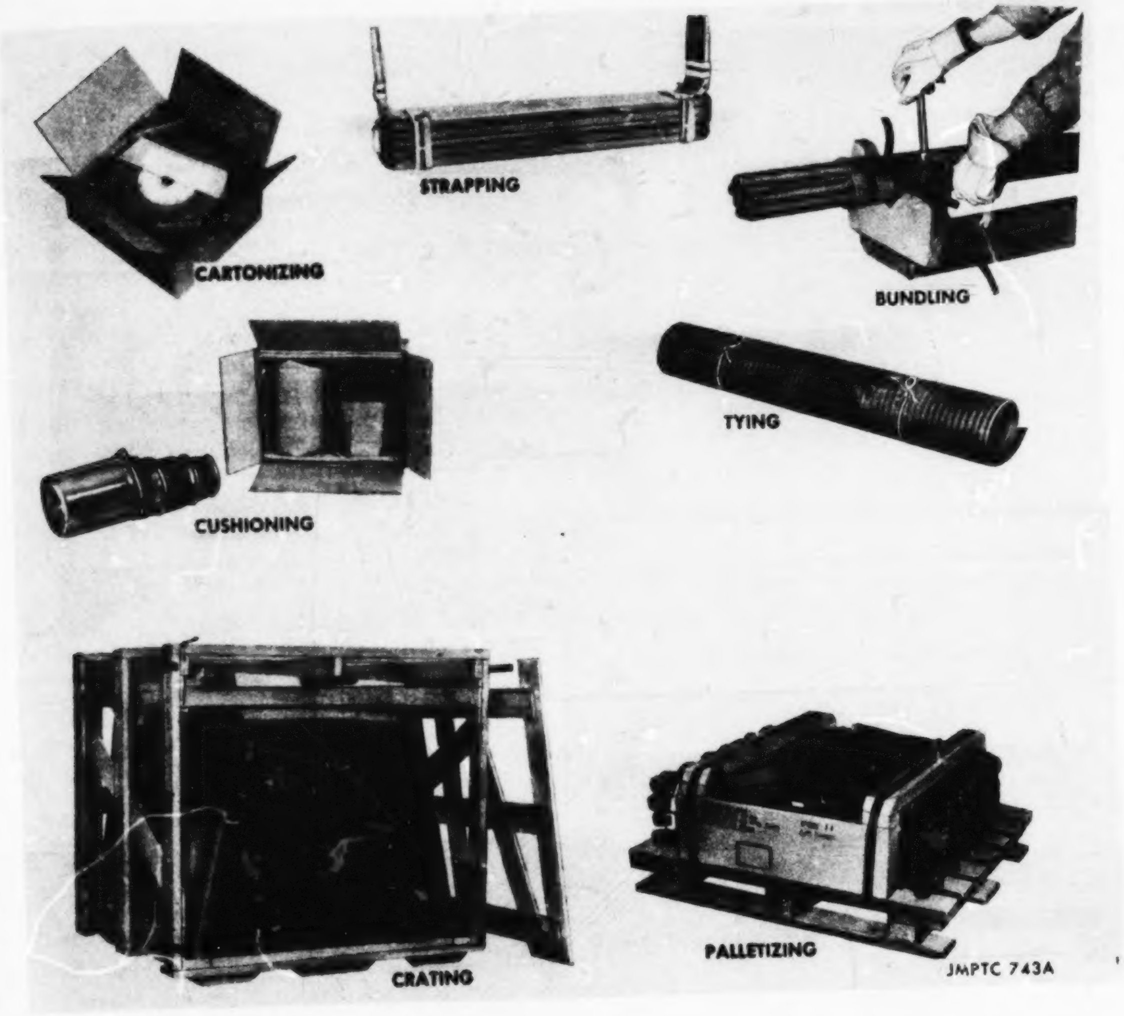


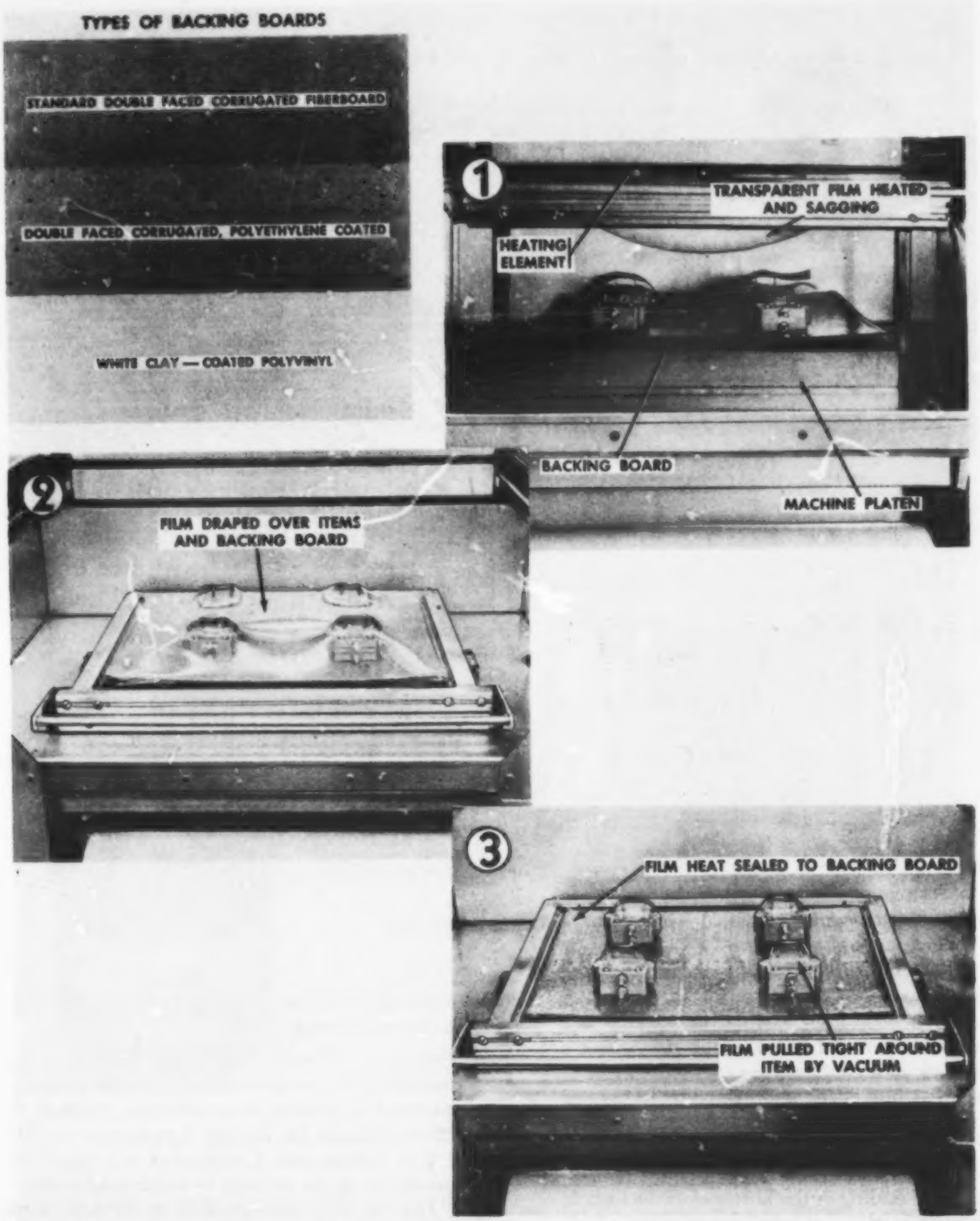
Figure 3-49. Application of method III.

(2) *Blister pack.* The blister pack; sometimes known as the "bubble" pack, varies from the skin pack in that the transparent film is performed around a mold, resulting in a configuration being imparted to the transparent film which approximates the general contours of the item to be packed. This preformed, rigid blister or bubble is usually formed with a flange ¼ inch or ½ inch in width. This flange permits the stapling, gluing, or sealing of the blister over the item to the backing (fig 3-52).

(3) *Shrink pack.* The shrink pack, unlike the two previous methods of packing, employs no vacuum but instead uses a heat tunnel and transparent films with a built-in memory. The item to be packed is wrapped in the film and then passed through the heat tunnel, where the heat shrinks the film (memory effect) to form a contour-fit pack.

d. Protection Afforded. The packs resulting from the application of the above techniques can generally be considered to provide, as a minimum, Method III protection. Methods IA, IC, and II protection may be afforded by making such provisions as will insure the impermeability of the package to water and/or water-vapor. This has been made possible by the Army's development of an automatic packaging machine (fig 3-41) which skin packs the item between two plastic films, the air being extracted from the sides rather than through the substrate.

e. Development and Application. The above descrip-


TYPES OF BACKING BOARDS
STANDARD DOUBLE FACED CORRUGATED FIBERBOARD
DOUBLE FACED CORRUGATED, POLYETHYLENE COATED
WHITE CLAY — COATED POLYVINYL
①
TRANSPARENT FILM HEATED AND SAGGING
HEATING ELEMENT
BACKING BOARD
MACHINE PLATEN
②
FILM DRAPED OVER ITEMS AND BACKING BOARD
③
FILM HEAT SEALED TO BACKING BOARD
FILM PULLED TIGHT AROUND ITEM BY VACUUM

JMPTC 917

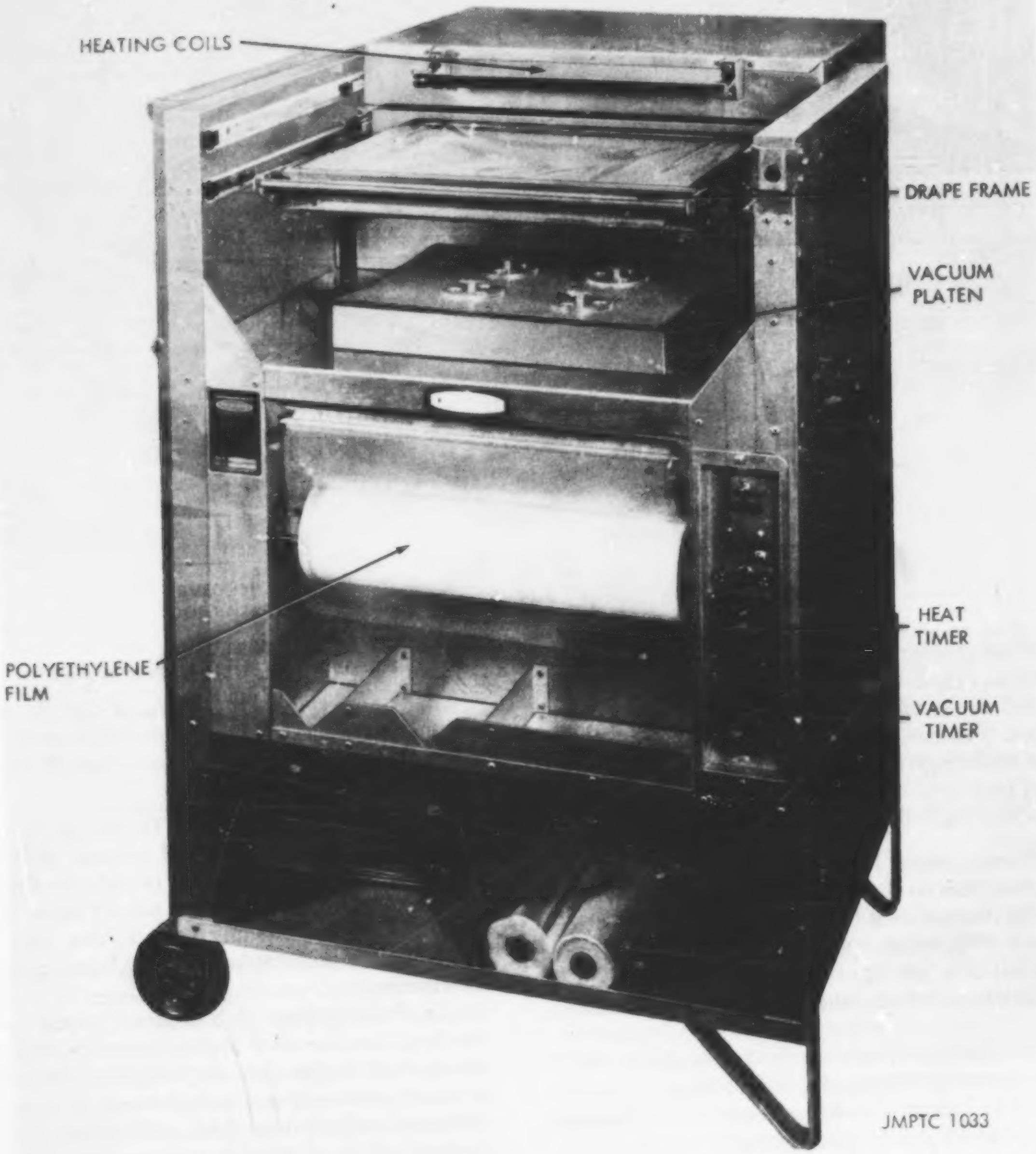

HEATING COILS
DRAPE FRAME
VACUUM PLATEN
HEAT TIMER
POLYETHYLENE FILM
VACUUM TIMER
JMPTC 1033

Figure 3-51. Vacuum forming machine

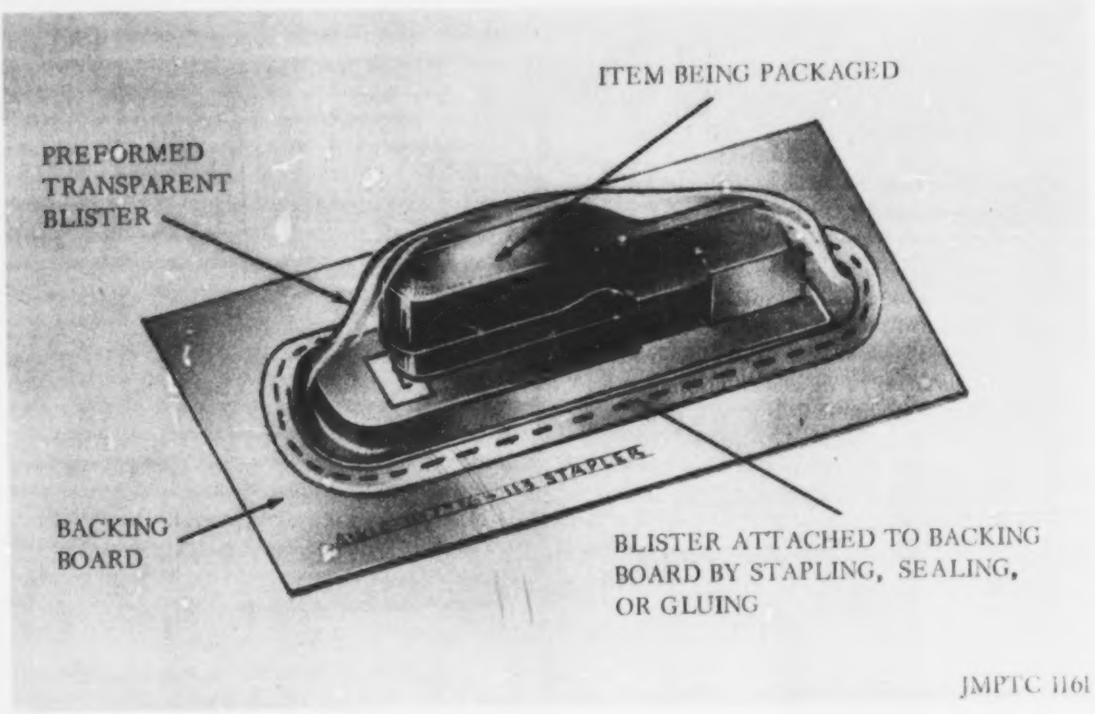

ITEM BEING PACKAGED
PREFORMED TRANSPARENT BLISTER
113 STAPLER
BACKING BOARD
BLISTER ATTACHED TO BACKING BOARD BY STAPLING, SEALING, OR GLUING
JMPTC 1161

Figure 3-52. Blister pack.

tion of thermoformed packing serves mainly as an introduction to this type of packing, which is relatively new and is rapidly developing. Further research of technical manuals, pamphlets, and texts, civilian, as well as military, is necessary in developing a particular type of pack or in establishing thermoformed packing at a facility (fig 3-53).

f. Thermoformed Packing Equipment. There are many machines on the market that are designed to accomplish thermoformed packing. These machines vary in size, configuration, productive capacity, and price range, but they are all of the same basic design. The simplest design includes the following components (fig 3-51):

(1) A rod-type heater, controlled to about 400°F output, mounted on the underside of a hood.

(2) Two actuator switches, one for the heating unit, the other for the vacuum pump.

(3) A master clamp frame and seal with spring-loaded lock grips.

(4) A drape mechanism.

(5) A machine platen, slightly smaller than the opening in the master clamp frame.

(6) A vacuum unit and parts.

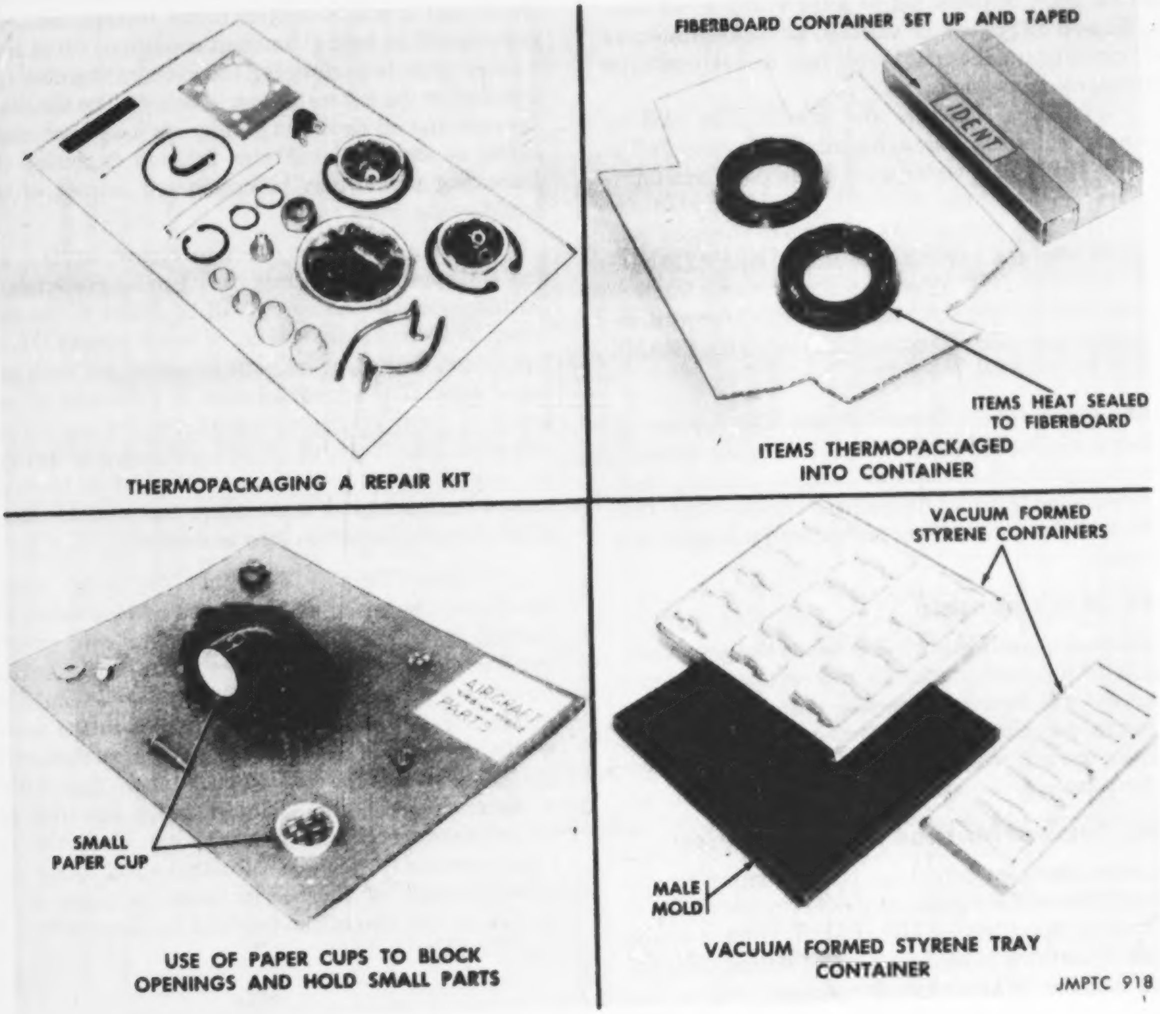
(7) A timer for controlling the heating and vacuum cycles.

(8) A mount for the roll of plastic film.

g. Thermoformed Process (fig 3-50). To perform the thermoformed process, the manufacturer's instructions should be followed for operation of the equipment.

h. Thermoplastic Materials. The materials vary depending on the thermoformed process utilized. The materials used in skin packing include the flexible vinyls, acetates, butyrates, and polyethylene. Each of these materials, excluding polyethylene, may be obtained with a polyethylene coating, or as a polyethylene laminate.

(1) *Polyethylene.* Polyethylene require slightly less heat than the other coating materials, and will adhere just as readily to the backing board. Polyethylene is widely used because of its lower cost. Some specially processed polyethylene films will adhere to a noncoated backing of ordinary paperboard or fiberboard; thus reducing the cost of the pack. Some packagers prefer to use polyethylene coated butyrate or acetate because it is very clear. The most commonly used thicknesses is a 4-mil film. Polyethylene coated vinyl chloride may react with certain preservative oils, and metal items coated with oil and packed with this film will become discolored as a result of this chemical action.


FIBERBOARD CONTAINER SET UP AND TAPED
IDENT
ITEMS HEAT SEALED TO FIBERBOARD
VACUUM FORMED STYRENE CONTAINERS
AIRCRAFT PARTS
SMALL PAPER CUP
MALE MOLD
JMPTC 918

THERMOPACKAGING A REPAIR KIT

ITEMS THERMOPACKAGED INTO CONTAINER

USE OF PAPER CUPS TO BLOCK OPENINGS AND HOLD SMALL PARTS

VACUUM FORMED STYRENE TRAY CONTAINER

Figure 3-53. Variations of plastic packages.

(2) *Backing board (fig 3-50).* The backing board to be used is as important a factor as the thermoplastic material itself. The backing boards most commonly used are—

(*a*) *White, clay-coated polyvinyl.* This board is coated with a layer of white clay and with a layer of polyvinyl chloride. It is to be used when the packaging film is uncoated polyvinyl chloride, or in the case of a polyvinyl-polyethylene laminate. The polyvinyl side of the film must face the board. The board is perforated through the polyvinyl coating only. This is because the polyvinyl coating is impervious to the flow of air, whereas the board stock is porous and will allow the air trapped between it and the film to be drawn out of the pack by the vacuum unit.

(*b*) *Double-faced, corrugated fiberboard, polyethylene coated.* This board is to be used when good adhesion to the polyethylene packing film is desired. This board is perforated through the polyethylene coating only, for the same reason as above.

(*c*) *Double-faced, corrugated fiberboard, non-coated.* For good adhesion, a specially processed polyethylene film must be used. The board is not perforated, nor is it finished with a glossy finish. This board cannot be used to pack metal parts intended for long-term storage. This is due to the sulfur content of the board, which, with the absorption of moisture from the air, will chemically attack and corrode the metal surfaces.

(*d*) *Other uses of backing boards.* Backing boards are very often used for advertising purposes or to convey information to the user, such as logistics date (stock number, nomenclature, unit of issue, etc.). Caution must be taken not to print with inks containing linseed oil, glycol, or varnish, as these substances will cause poor adhesion. Water-base and solvent-type inks are recommended.

(*e*) *Plastic substrate* and smooth film used by the Army automatic packaging machine is described in MIL-P-45215. It is waterproof, greaseproof and fabricated especially for use in vacuum forming machines.

(*f*) *Safety precautions.* The top of the hood gets very hot after the heating coils are on. KEEP HANDS AND ELBOWS OFF. When the master clamp frame is raised to insert the plastic film, it may fall forward, injuring the operator's fingers. SUPPORT THE FRAME WHEN IT IS OPEN.

3-34. Unit Pack Quantities. The number of items in a unit pack shall be specified in the contract or work order. When not specified the quantity shall be determined by using Appendix F of MIL-STD-794, Parts and Equipment, Procedures for Packaging and Packing.

3-35. Workmanship

Workmanship shall be such that, when the proper procedure is followed, materials and equipment being processed will receive the required protection against corrosion, deterioration, and damage during shipment and storage, and will require the minimum of processing for service.

3-36. Tests of Method of Preservation

The tests described herein are used to determine the effectiveness of the various methods of preservation as set forth in Specification MIL-P-116. When a combination of methods is used for a specific item, tests applicable to the various methods employed will be used (table 3-11). To be acceptable, the packaging materials and the item within the unit pack must show no signs of damage or operational malfunction due to deterioration as a result of a test.

3-37. Tests for Determining Cleanliness

The cleanliness tests of visual examination, wiping, and freedom from alkalies and acids are explained in paragraph 1-13.

3-38. Determination of Preservative Compound Application

The continuity and appearance of preservatives after application will be determined visually. Coatings which are not uniform and homogenous shall be cause for rejection. Hard preservative films shall be examined closely for breaks in coating.

3-39. Leakage Tests (Method 5009 of Federal Test Method Standard No. 101)

a. General. Unit packs conforming to basic Methods IA, IC and II will be subject to the leakage tests. All samples will be held at ambient conditions for at least 4 hours prior to performing the vacuum chamber test (*c* below) or the hot water test (*d* below). The time that the item and all processing materials have been maintained at ambient conditions prior to or during the processing period may be considered as part of the conditioning time.

b. Wetting Agent. In order to remove surface air and entrapped air in scrim back barrier materials, a wetting agent or detergent will be added to the test water. Approximately five cc. of liquid aerosol OT, or equivalent wetting agent, will be added per each gallon of water. The aerosol solution, or a solution of four grams of water soluble detergent; conforming to Specification MIL-D-16791, Type I, per gallon of test water, will effectively release the entrapped air in scrim backed flexible barrier materials so that actual leakage of air through the barrier may be detected.

c. Vacuum Chamber Technique (fig 3-54). Packs conditioned as specified in *a* above will be tested for leakage by submerging the filled and sealed sample bag, pack or can, a maximum of 1 inch, in water contained in a vacuum vessel and drawing a vacuum. Submerge the specimen in water contained in the vessel within the vacuum chamber. The uppermost surface of the specimen shall be covered by not more than 1 inch of water. Evacuate the chamber to the specified vacuum pressure. Unless otherwise specified, the vacuum pressure (P) shall be calculated equal to the specified strength of the barrier seam (S) times pi (π) divided by the sum of the two smaller dimensions (d1 and d2) of the package.

$$P = \frac{SX\pi}{(d1 + d2)}$$

(*For example,* to test a pack 10 by 6 by 4 inches inclosed in MIL-B-131 barrier material, the vacuum pressure shall be the specified strength of MIL-B-131 barrier seam (3½ lb./in.) times pi (3.14) divided by the sum of the smaller dimensions (6 + 4 inches); that is, the vacuum pressure shall be 11/10 or 1.1 lb/sq in.) For other sizes other pressures shall be calculated in a similar manner or read from an appropriate curve (fig 3-55). Hold the vacuum for 30 seconds while observing the submerge specimen for leakage. Invert the specimen and repeat the test. Record locations of leaks or state, "no leaks."

d. Hot Water Technique. When the size or shape of the pack precludes the use of the vacuum vessel, the following test will be used: The pack will be conditioned as specified in *a* above and immersed in water heated to a temperature of at least 50°F above the

Table 3-11. Schedule of Quality Conformance Tests

Method or submethod	Preservative compound application	Leak tests (vacuum) chamber test)	Heat seal test	Marking and labeling (note 2)	Workmanship (note 4)
I	Required			Label on initial wrap and on container when used. (Identification not required on grease-proof wraps placed in snug containers where identification is on on the container)	Minimum air void inside package. No damage of preservative by excessively tight wrap. Cushioning or blocking as required.
IA-5	Required when preservative is specified.	Required (note 8)		Markings applied directly on metal containers.	Minimum air void. If additional protection other than basic wrap is needed for protection, cushioning or blocking should be used.
IA-6	Required	Required		Markings applied directly on metal containers.	Container of appropriate size for item with room for expansion of preservative.
IA-8	Required when preservative is specified	Required (note 5)	Required	Marking applied on bag and on container when used (note 11).	Appropriate size bags. Minimum air void. Cushioning as required.
IA-13		Required (note 8)		Markings applied on container.	Minimum air void. If additional protection other than basic wrap is needed for protection, cushioning or blocking should be used.
IA-14		Required (notes 7 and 9).		Markings applied on barrier and outer container.	Minimum air void. Cushioning or blocking as required. Corners of inner carton blunted.
IA-15		Required (notes 5, 7 and 10).	Required	Markings applied on barrier and on outer wrap when used.	
IA-16		Required (notes 6 and 9).		Markings applied on barrier and on outer container.	Minimum air void. Cushioning or blocking as required.
IB-1				Markings applied on barrier and on overwrap or container when used.	Satisfactory thickness of coating 0.005 in.; small part 0.025 inch minimum.
IB-2	Required			Markings applied on barrier and on overwrap or container when used.	Cords for dipping shall be sealed and treated. Coating shall be uniform, homogeneous and shall not stick to item on removal.
IC-1				Marking applied on bag and on container when used (note 11).	Appropriate size bag. Minimum air void. Cushioning as required.
IC-2		Required	Required	Markings applied on barrier and outer container when used.	Minimum void. Cushioning or blocking as required. Corners of inner carton blunted.
IC-3				Marking applied on bag and on container when used (note 11).	Appropriate size bag. Minimum air void. Cushioning as required.

Method or submethod	Preservative compound application	Leak tests (vacuum) chamber test)	Heat seal test	Marking and labeling (note 2)	Workmanship (note 4)
IC-4	Required when preservative is used	Required (notes 3 and 8).	....	Markings applied on container.	Minimum air void. If protection other than basic wrap is required, cushioning or blocking should be used.
IC-7		Required	....	Markings applied on blister pack (note 11).	Minimum air void. Item immobilized within pack. Plastic evenly distributed.
IC-9		Note 5	....	Marking applied on skin pack (note 11).	
IC-10 ...		Note 5	....	Markings applied on skin pack (note 11).	
IIa		Required (notes 5, 6 and 9).	....	Markings applied on barrier and outer container (note 11).	Minimum air void. Desiccant-proper amount used. See Formula I and II. Humidity indicator properly placed. Humidity indicator window when required. With flexible barrier, sufficient material provided at closure edge. Cushioning and blocking as required. Corners of inner carton blunted for submethods IIb and IIe.
IIb		Required (notes 5, 7 and 9).	Required	Markings applied on barrier and outer container.	
IIc	....	Required (note 5)	....	Marking applied on bag and on container when used (note 11).	
IId	....	Required (note 8)	....	Markings applied directly on metal container.	
IIe	....	Required (notes 5, 7 and 10).	Required	Markings applied on barrier and outer wrap, when used.	
IIf	....	Required (note 9)	....	Markings applied on container.	
III	....	....	....	Markings on wrap and container when used. (See note 11). (Identification not required on wraps placed in snug containers where identification is on the container).	Dunnage and wrapping of container as applicable, to prevent contamination and physical damage in storage.

Notes. 1. Determination of cleanliness required for all basic methods and submethods.

2. When a container for a unit or multiple unit package is used also as an exterior shipping container, the marking applicable to shipping containers as specified in MIL-STD-129 shall be used in lieu of pack markings. Identification is not required on wraps placed in snug containers, where identification is on the container.

3. The submersion test may be used in lieu of vacuum chamber test for rigid containers sealed with tape.

4. Materials for preservation-packaging shall be as required for the specific method and as specified in the contract or order.

5. When size or shape of the pack precludes the use of the vacuum chamber test the hot water technique or vacuum retention test may be used in lieu of the vacuum chamber test.

6. Vacuum Retention Test may be used in lieu of the Vacuum Chamber Test.

7. When specified by the procuring agency, the Vacuum Retention Test shall be used on specified items in lieu of the Vacuum Chamber Test.

8. Pneumatic Pressure Test may be used in lieu of the Vacuum Chamber Test. MIL-C-3955 cans may be tested by the Submersion Test in lieu of the Vacuum Chamber Test.

9. Remove outer container prior to testing.

10. Outer wrap, when used, shall be removed prior to testing.

11. Transparent or opaque lables may be inserted in transparent unit containers when the label can be placed in a stationary position and will not affect or be affected by the method of preservation. Opaque labels shall not obscure more than 50 percent of one surface of transparent unit containers.

temperature at which the pack was conditioned. The upper face of the pack will be parallel to, and not more than 1 inch below the surface of the water. Each face of the pack will be rotated to the same position until the entire surface of the container has been examined. Each seam and face of the pack will be observed for a minimum period of 15 seconds and a total elapsed time not to exceed 2 minutes.

e. Interpretation of Results. Observation of evolution of air bubbles shall be made at each position of the sample. Bubbles which appear on the surface of the pack but are not released are not to be construed as indication of failure. A steady or recurring succession of bubbles from any surface or seam will be cause for rejection.

f. Submersion (or Immersion) Techniques (fig 3-56). Packs conditioned as specified in *a* above shall be submerged so that the uppermost surface is beneath the water surface not less than 1 inch nor more than 2 inches for 1 hour or longer in water maintained at a temperature of not less than 40°F below the temperature at which the specimen is sealed. After submersion and before opening the specimen, carefully dry the outside of the specimen where the opening will be made. Then open the specimen.

g. Interpretation of Results. Evidence of moisture within the barrier will be cause for rejection.

h. Vacuum Retention Technique. The flexible barrier inclosing the item will be sealed except for an opening at one end to accommodate a tube which is connected to a vacuum producing apparatus (aspirator or vacuum pump). A vacuum of nine mm plus or minus one mm of mercury or 5 inches plus or minus ½ inch of water measured by gage or watermanometer, respectively, will be drawn on the sealed pack and the tube closed. The required vacuum may be drawn more than once to insure that equilibrium within the barrier has been reached.

CAUTION

> An excessive vacuum may damage the flexible barrier material.

Loss of vacuum shall be determined after the pack has remained undisturbed for 10 minutes. To facilitate performance of the vacuum retention test, a pneumatic tire valve may be installed in the barrier approximately 1½ inch from the line of closure (fig 3-57). Grooves should be cut across the base of the tire valve to prevent the flexible barrier from blocking the core opening. Soft rubber gaskets placed on each side of the barrier will prevent leakage around the valve when the assembly is tightened in place. Bags previously sealed may have one corner cut off to permit installation of the valve. The cut edge is resealed after the valve is installed. Unless otherwise specified, the valve will be removed after the completion of the test.

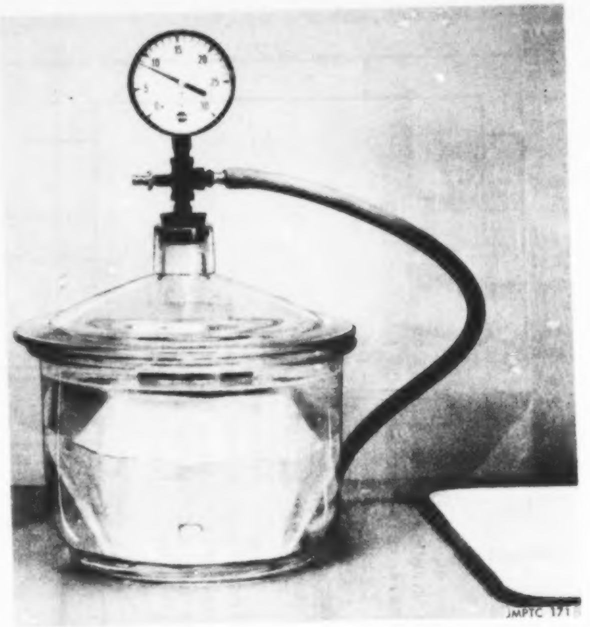


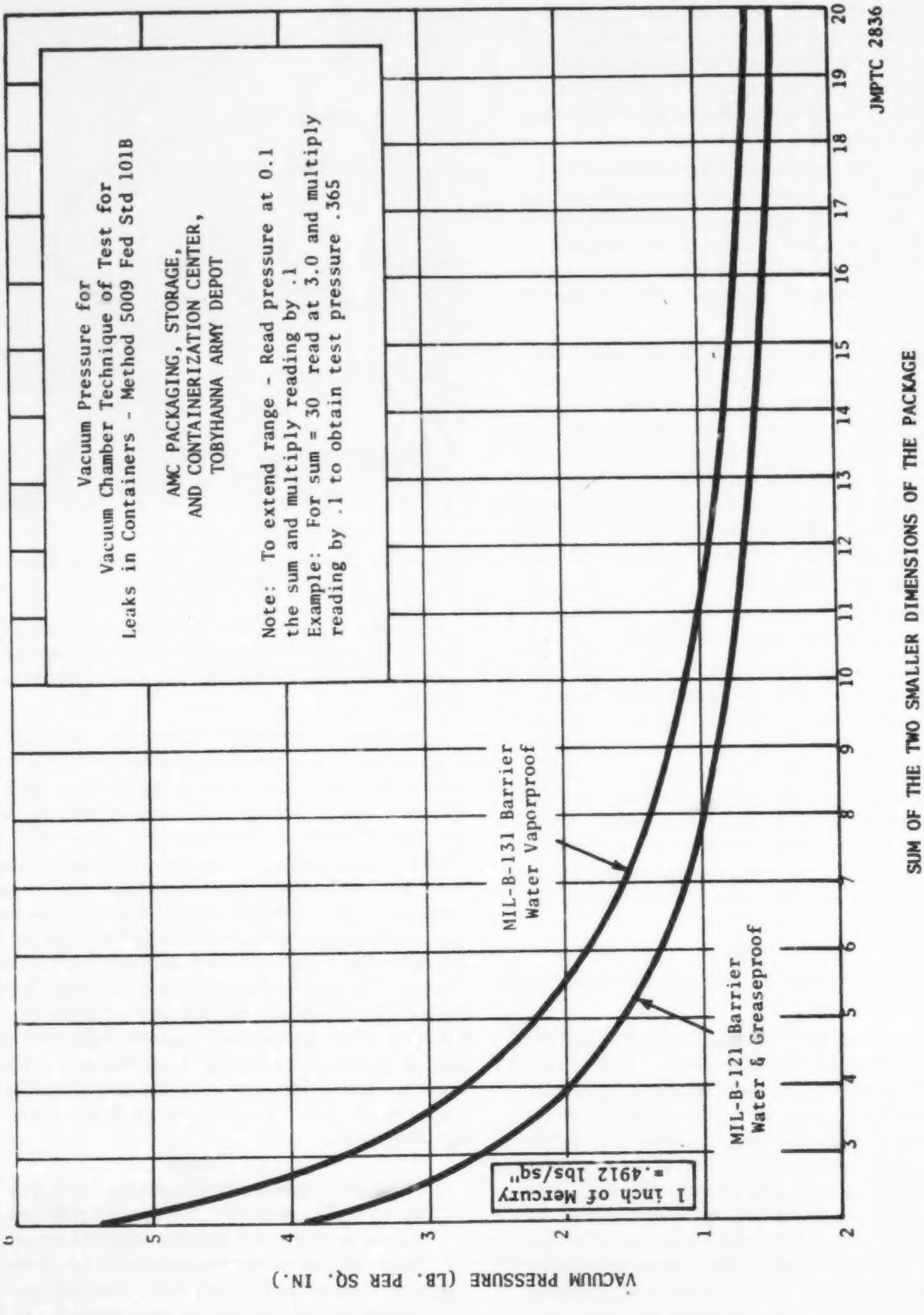
Figure 3-54. Vacuum chamber, technique for heat sealed packages.

i. Interpretation of Results. A loss of vacuum from the sealed system will not exceed 25 percent of the original vacuum after remaining undisturbed for 10 minutes.

j. Pneumatic Pressure Technique. During the preparation of the specimen, provision shall be made for connecting a tube to compress the air within the specimen and to connect with a gage that will sense any loss in pressure. Such provision may be a tube sealed into an opening at one end of a seam in flexible barrier, a drilled and tapped plug, a valve stem incorporated in a container, or other acceptable device that can be either sealed or removed so that the container can be reclosed or resealed upon completion of the specimen and to the gage. Gradually introduce air until either the prescribed pressure in the specimen is attained or leakage becomes apparent. When the specimen is pressurized to a constant specified pressure, close the line to the compressed air supply leaving the gage connected to the specimen. Read and record the initial pressure.

CAUTION

> Pneumatic pressure may cause explosive failure of weak specimens. The applied pressure should be no greater than necessary to reveal leaks. Unless otherwise specified, the pressure shall be determined in the manner prescribed for calculating vacuum pressure in *c* above. The specified pressure may be applied more than once to insure that equilibrium



Vacuum Pressure for
Vacuum Chamber Technique of Test for
Leaks in Containers - Method 5009 Fed Std 101B

AMC PACKAGING, STORAGE,
AND CONTAINERIZATION CENTER,
TOBYHANNA ARMY DEPOT

Note: To extend range - Read pressure at 0.1 the sum and multiply reading by .1
Example: For sum = 30 read at 3.0 and multiply reading by .1 to obtain test pressure .365

Figure 3-55. Vacuum chamber curve.

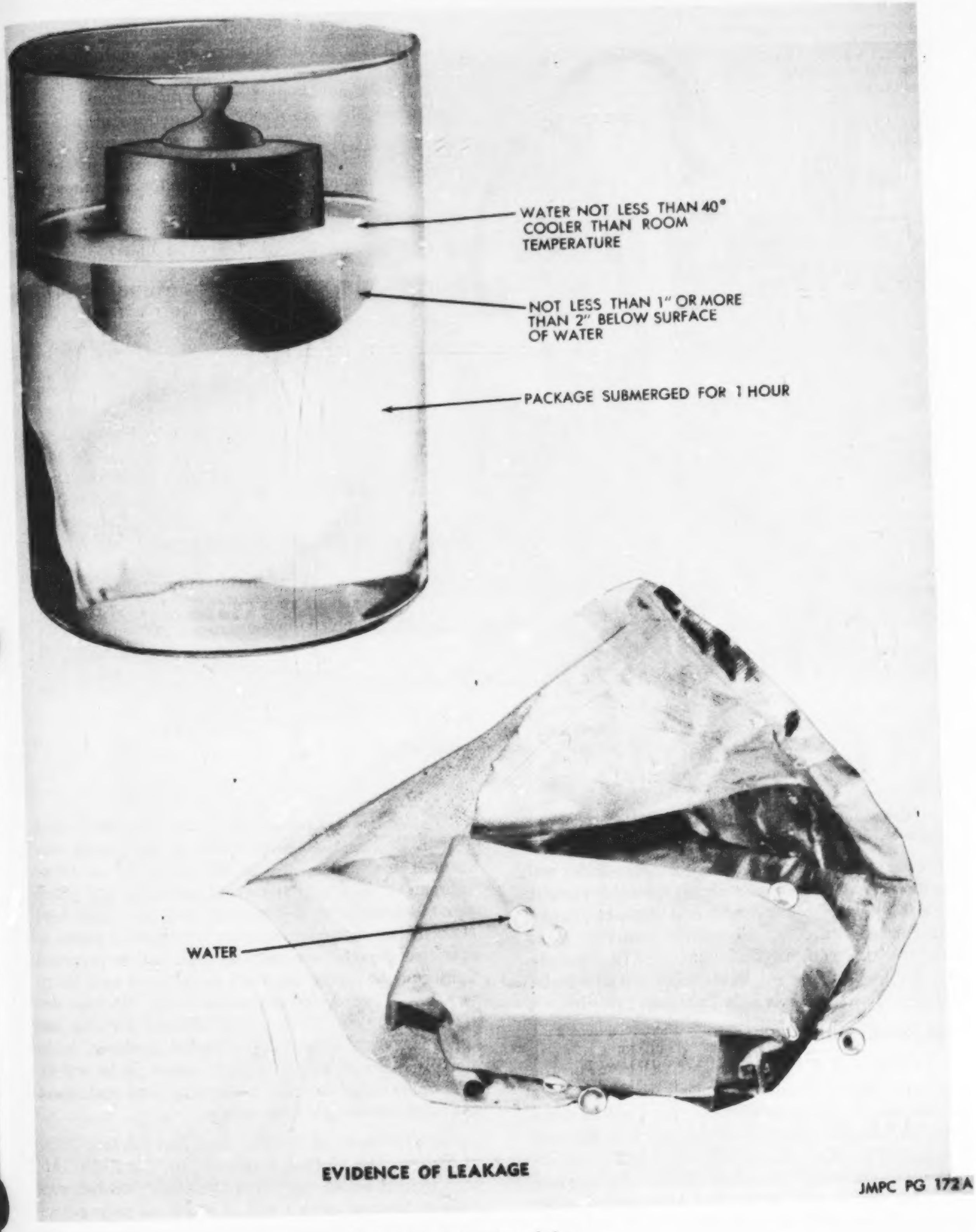

WATER NOT LESS THAN 40° COOLER THAN ROOM TEMPERATURE
NOT LESS THAN 1" OR MORE THAN 2" BELOW SURFACE OF WATER
PACKAGE SUBMERGED FOR 1 HOUR
WATER
EVIDENCE OF LEAKAGE
JMPC PG 172A

Figure 3-56. Submersion technique.

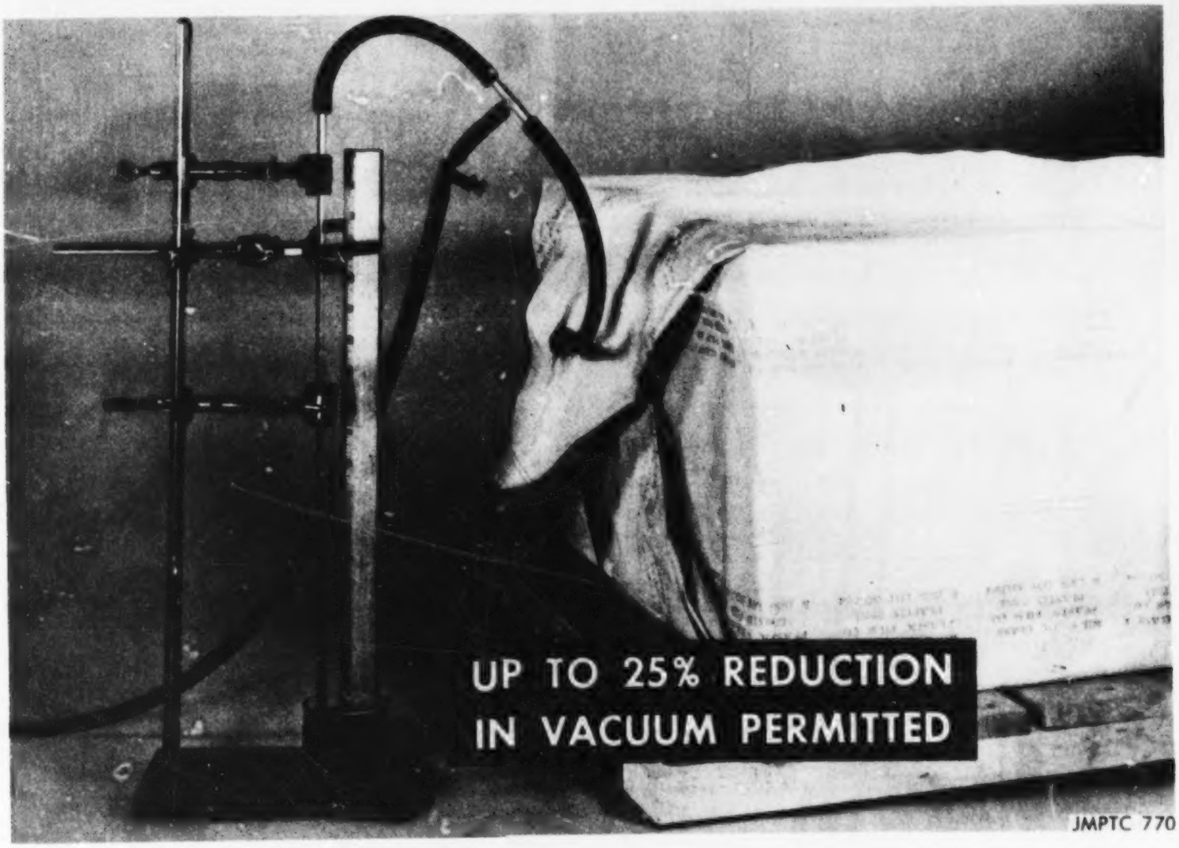


Figure 3-57. Vacuum retention technique.

within the specimen is reached at the pressure.

Either submerge the specimen 1 or 2 inches under water and observe for leakage with the specimen upright and with the specimen inverted; coat all seams, joints, casting connections, and other likely points for leaks in the specimen with a bubble-supporting film and observe for leakage. Record locations of leaks or state, "no leaks." Read and record the final gage pressure.

3-40. Heat Seal Test

a. Selection of Samples for Test. Sections of the heat seals will be obtained from sealed unit packages. The number of sealed specimens required will be in accordance with sampling procedures given in Military Standard MIL-STD-105 or MIL-STD-1235, and inspection levels are given in MIL-P-116. For requirements for sample size, lot size and Acceptable Quality Level (AQL) see MIL-P-116, para 4.2.2.3, 4.2.2.3.1, 4.2.2.3.2.

b. Alternate Sampling Procedure for Heat Seal Test. When heat seals are made on equipment conforming to MIL-S-4461 or MIL-S-22783 (or other equipment designed to control pressure and dwell time), samples may be prepared from specimen heat seals in lieu of taking samples from sealed packs as specified above. Specimen heat seals will be prepared daily prior to production from sample(s) of each barrier material sealed on each sealing device. Machine settings used in production will be identical with the settings used in fabrication of the tested specimen. Additionally, tests of heat seals from actual packs will be performed as necessary to assure that pack seals meet the requirements given in c below.

c. Performance of the Heat Seal Test (Method 2024 of Federal Test Method Standard 101) (fig 3-58). After the heat sealed seams are thoroughly cooled, sections of the heat seals 1 inch in width cut perpendicular to the line of the seal, will be obtained from the test specimens or pack barriers as applicable. The length of

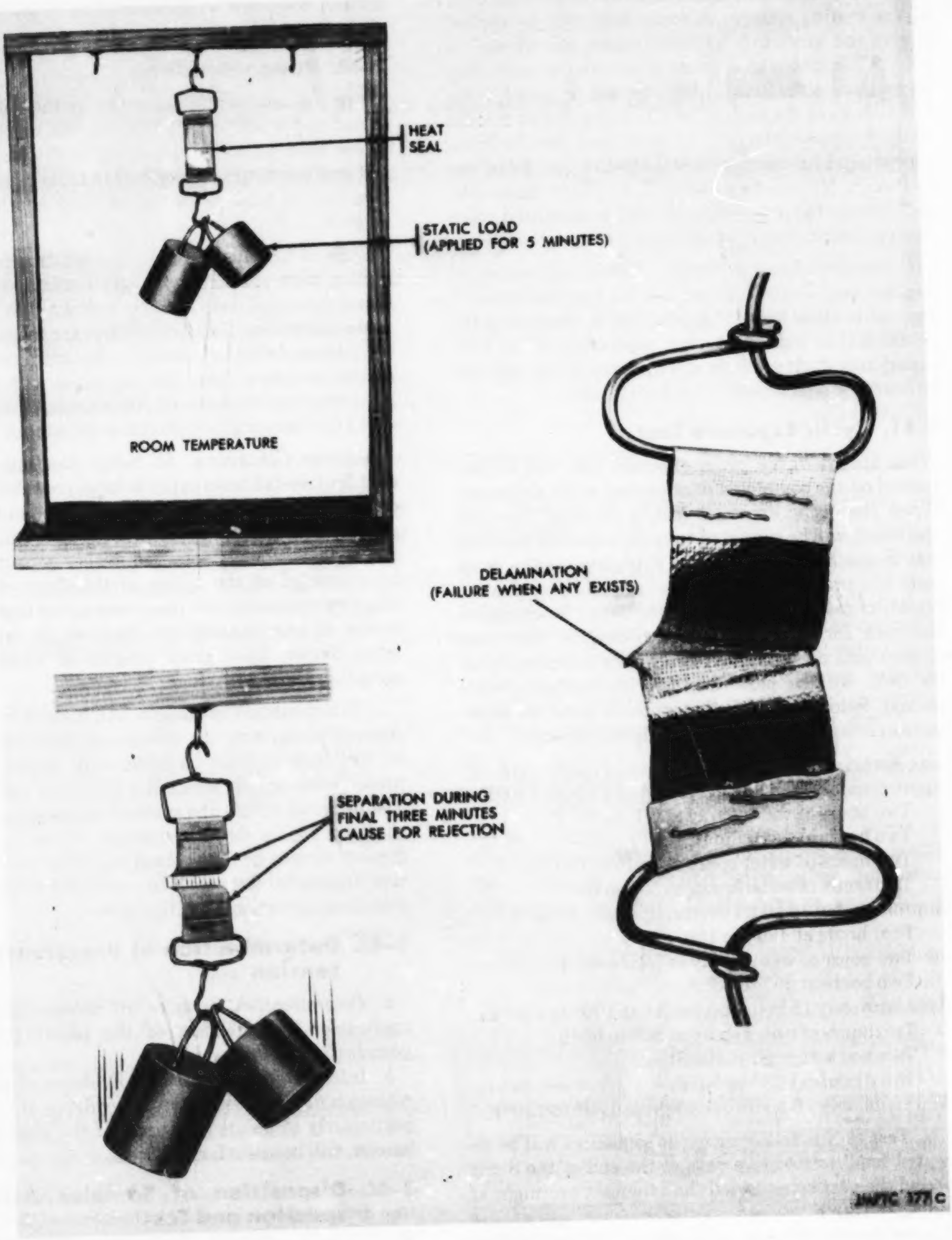

HEAT SEAL
STATIC LOAD (APPLIED FOR 5 MINUTES)
ROOM TEMPERATURE
DELAMINATION (FAILURE WHEN ANY EXISTS)
SEPARATION DURING FINAL THREE MINUTES CAUSE FOR REJECTION
JMTC 177 C

Figure 3-58. Heat seal test.

the legs of the test section is not critical. The sections will be unfolded and clamped with the line of the seal perpendicular to the direction of the load application. The seams will be positioned midway between the jaws of the testing clamps. A static load will be applied slowly and uniformly without impact and allowed to act for 5 minutes at ambient room temperature. Any separation at the heat sealed area will be noted, without disturbing the seal, after 2 minutes and at the end of the 5-minute interval. The static load shall be 36 oz. for material conforming to MIL-B-121, and 50 oz. for L-P-378, MIL-B-131 and MIL-B-22191 materials. A 5-percent reduction in static load is permitted when the room temperature in the test area exceeds 90°F.

d. Interpretation of Results. Partial separation of the heat seal is exceptable within the first 2 minutes of the test to allow areas of partial fusion adjacent to the actual seal to pull apart. Any separation of the heat sealed area during the final 3 minutes of the test will be cause for rejection.

3-41. Cyclic Exposure Test

When specified, the cyclic exposure test will be performed on the completed pack packed as for shipment. When the cyclic exposure test is required, the test specimens will be subjected to cyclic exposure test A or test B specified below before final acceptance. Such tests will precede applicable leakage and preservative retention tests specified in table 3-11. Examination and test for leaks in barrier materials, seals and closure, and preservative retention as indicated in table 3-7, will be performed on the contained unit pack(s), following the cyclic exposure tests, to determine existence or extent of detrimental effects.

a. Test A.

Approximately 16 hours overnight at 120° to 130°F.
  Two hours of water spray at 50° to 60°F.
  Two hours at − 10° to 0°F.
  Two hours of water spray at 120° to 130°F.
  Two hours of water spray at 50° to 60°F.
Approximately 16 hours overnight at 35° to 50°F.
  Four hours at 120° to 130°F.
  Two hours of water spray at 50° to 60°F.
  Two hours at 35° to 50°F.
Approximately 16 hours overnight at 120° to 130°F.
  Two hours of water spray at 50° to 60°F.
  Two hours at − 10° to 0°F.
  Three hours at 35° to 50°F.
Approximately 16 hours overnight at 120° to 130°F.

b. Test B. The following cyclic sequences will be repeated for 3 consecutive days at the end of the 3 day period the part being tested shall then set overnight at 120°F to 130°F.

Approximately 16 hours overnight at 120° to 130°F.
  Two hours of water spray at 50° to 60°F.
  Four hours at 120° to 130°F.
  Two hours of water spray at 50° to 60°F.

c. Interpretation of Results. The tested pack, when opened, will show no evidence of moisture or corrosion of the item.

3-42. Rough Handling

When the unit container serves as the shipping container and *a* and *b* below apply, the completed container shall be tested according to Federal Standard 101 and the methods specified in table 3-12 except as modified by table 3-13 for the drop and impact test heights.

a. Small Containers. Only free-fall drop tests and vibration tests shall apply to small containers; both or either vibration tests shall be conducted at the option of the contractor. Small containers are those having no one edge or diameter over 60 inches and a gross weight of 150 pounds or less. Any container with skids, any item weighing in excess of 100 pounds, or any item secured to a base will be tested as a large item.

b. Large Containers. All rough handling tests, except for free-fall tests apply to large containers. Either or both vibration tests shall be conducted at the option of the contractor. However, tipover tests will apply only when additionally specified. Either impact test shall be conducted at the option of the contractor. Large shipping containers are those measuring more than 60 inches on any one edge or diameter, or those which when loaded, have gross weights in excess of 150 pounds or those with skids.

c. Interpretation of Results. All materials and components comprising the method of preservation shall be free from damage or evidence of displacement of preservative which affect the utility of the method. The material within the method of preservation shall show no visible signs of damage. When evidence of damage cannot be determined solely by visual inspection; functional tests shall be conducted to insure freedom from operational malfunction.

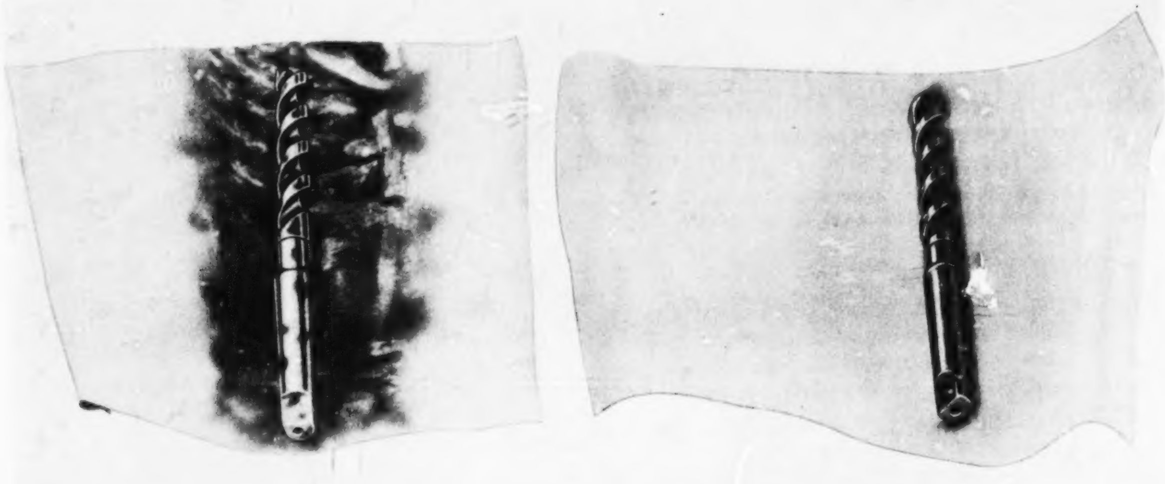
3-43. Determination of Preservative Retention

a. Determination. Samples will be examined, where applicable, for retention of the preservative compounds (fig. 3-59).

b. Interpretation of Results. Evidence of failure of retention of the preservative or evidence of corrosion, particularly at points of contact of the item with the barrier, will be cause for rejection.

3-44. Disposition of Samples After Inspection and Test

All samples used for inspection and tests will be reprocessed as necessary. They may, after reprocess-



PRESERVATIVE NOT RETAINED ON ITEM

PRESERVATIVE RETAINED ON ITEM

JMPC PG 176

Figure 3-59. Determination of preservative retention.

ing in accordance with the original method of preservation, be considered a part of the original lot. When the packed item may have been damaged as a result of testing, it will be inspected and tested as necessary to determine its acceptability.

Table 3-12. Rough Handling Tests

Test	Methods of FED-STD-101	Special requirements or exceptions
Free-fall drop tests:		Notes 1 and 3
Corner drop	5007 Procedure E	Note 2
Flat drop	5007 Procedure B	Note 2
Tipover	5018	
Rotational drop tests:		Note 1
Edgewise	5008	
Cornerwise	5005	
Impact Tests:		Note 1
Pendulum	5012	
Incline	5023	
Superimposed load:		Note 4
(stackability with dunnage)	5016	
(uniformly distributed without dunnage)	5017	
Vibration:		Note 1
Repetitive shock	5019	
Sinusoidal motion	5020	

Notes. 1. Unless otherwise specified, the contractor shall have the option as to what method is to be applied in accomplishing the free-fall, rotational, impact, and vibration tests.

2. Containers employing internal cushioning, blocking or bracing shall be subjected to both corner and flat drop tests.

3. Items having a net weight exceeding 100 pounds and which are secured to a base within or to the base of a container shall be tested as indicated for larger containers.

4. Unless otherwise specified, both methods shall be applied.

3–45. Intermediate Packing

Intermediate packing is the packing of two or more identical unit packs into another container which will be inclosed along with other such packs in an exterior shipping container. Intermediate packs facilitate handling, storing, inventorying, and other physical functions (fig 3-60).

3–46. Marking of Unit and Intermediate Packs

a. General. Markings applied to labels or directly to barriers or interior containers identify the packaged item and give other important information in regard to the unit or intermediate

Table 3-13. Graduated Drop and Impact Test Heights

Gross weight of container and contents	Edgewise drop (2 drops each end)	Cornerwise drop test (2 drops on each of 2 diagonally opposite corners of bottom)	Impact tests (1 impact on each of 2 opposite ends) (Use either test)	
Pounds	Height of drop (inches)	Height of drop (inches)	Pendulum impact (inches)	Incline impact (feet)
Through 250	30	30	14	7.0
Over 250 thru 500	24	24	11	5.5
Over 500 thru 1000	18	18	8	4.0
Over 1000	12	12	5	2.5

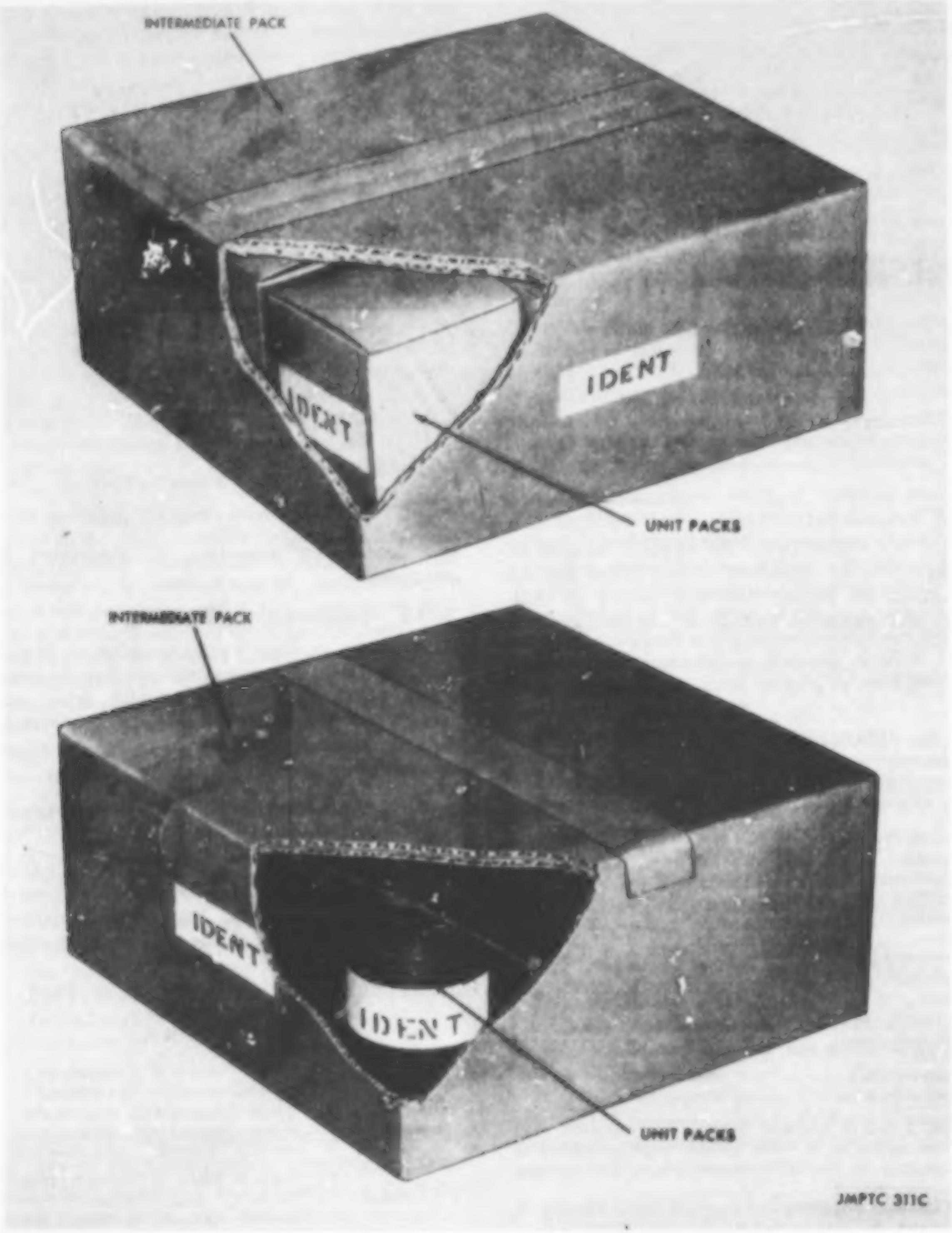

INTERMEDIATE PACK
IDENT
IDENT
UNIT PACKS
INTERMEDIATE PACK
IDENT
IDENT
UNIT PACKS
JMPTC 311C

Figure 3-60. Intermediate Packs.

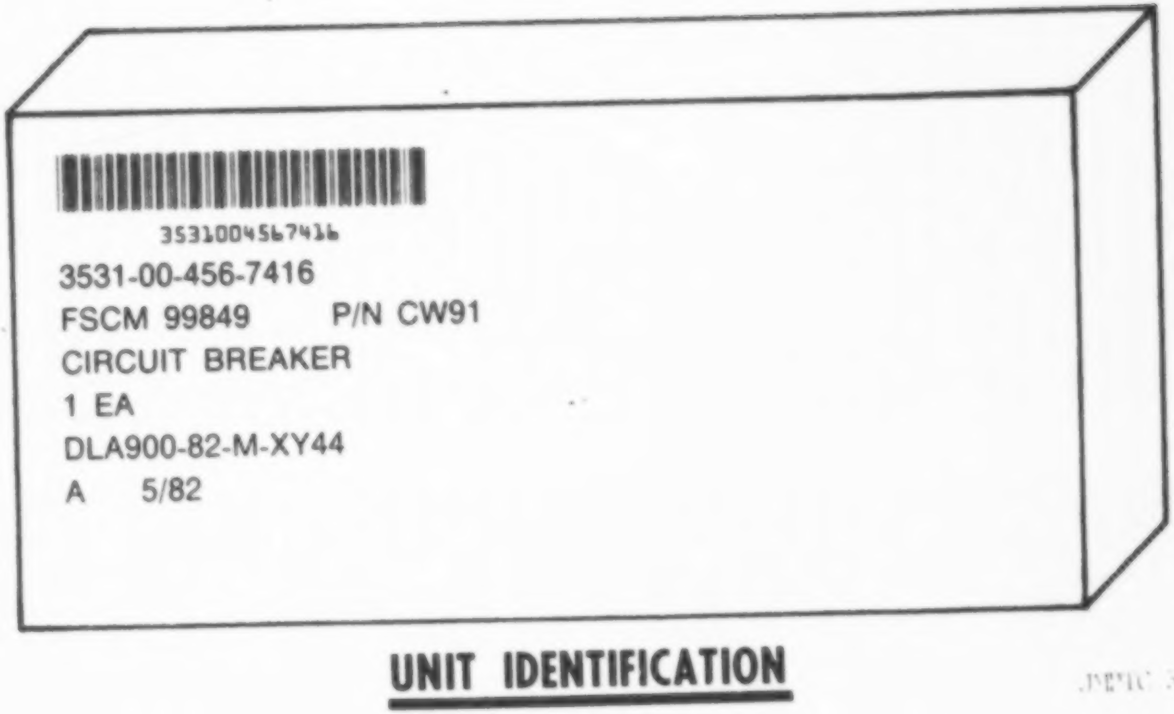

3531004567416
3531-00-456-7416
FSCM 99849 P/N CW91
CIRCUIT BREAKER
1 EA
DLA900-82-M-XY44
A 5/82
UNIT IDENTIFICATION

Figure 3-61. Interior pack markings (MIL-STD-129).

packs. Lack of proper markings on unit or intermediate packs will cause serious difficulties and problems in the supply system. A unit or intermediate pack is not complete until it has been properly identified. Table 3-11 gives instructions on the marking and labeling of unit packs. The requirements for lettering, waterproofing, and securing of labels are discussed in paragraph 3-4*h*.

b. MIL-STD-129 Requirements. Marking of unit and intermediate packs will be done in accordance with Military Standard MIL-STD-129, which requires the following information to appear on all unit and intermediate packs (fig 3-61):

(1) National stock number.
(2) FSCM and/or MFR/PN
(3) Item description.
(4) Quantity and unit.
(5) Contract or purchase number.
(6) Level of preservation and packing and date.

c. Special Markings. Special markings will be in accordance with the requirements of MIL-STD-129 and the contract or order.

(1) Requirements for the use of Method II labels are given in Paragraph 3-25*d*.

(2) Packs containing radioactive material will be marked in accordance with Military Standard MIL-STD-129.

d. Bar Code. When specified the National Stock Number will be shown as a bar code as described in MIL-STD-129.

Table 3-13. Graduated Drop and Impact Test Heights

Gross weight of container and contents	Edgewise drop (2 drops each end)	Cornerwise drop test (2 drops on each of 2 diagonally opposite corners of bottom)	Impact tests (1 impact on each of 2 opposite ends) (Use either test)	
Pounds	Height of drop (inches)	Height of drop (inches)	Pendulum impact (inches)	Incline impact (feet)
Through 250	30	30	14	7.0
Over 250 thru 500	24	24	11	5.5
Over 500 thru 1000	18	18	8	4.0
Over 1000	12	12	5	2.5

CHAPTER 4
SPRAYABLE, STRIPPABLE FILMS AND CONTROLLED HUMIDITY

4-1. Sprayable, Strippable Films

a. General. The use of spray-applied synthetic vinyl resins carried in solvents is a common method of protecting large, bulky pieces of equipment for long-term storage, or sealing door and window joints in various vehicles. There are various types of sprayable, strippable films, each described by specification.

(1) *MIL-C-16555.* This specification covers one type of coating intended to protect metal and fabric surfaces from deterioration and physical damage on items in outdoor storage and during shipment. It is capable of being sprayed and stripped from painted surfaces in addition to metal and fabric surfaces. The film can be peeled off in large pieces quickly.

(2) *MIL-C-6799.* This specification covers the requirements for water emulsion, protective, strippable, sprayable, singlecoat or multicoat coatings for application over metallic, painted, and plastic surfaces. They are classified in 3 types and four classes. Type I—Single Coat (interior or undercover) has two classes; Class 1—Transparent, Class 2—Opaque, which are intended for protecting material when it is shipped fully covered or stored under protective cover. Both classes can be used where the protected acrylic must undergo processes of sawing, sanding, drilling or routing. Type II—Multicoat system (exterior) has three classes; Class 1—Base coat (black) is intended for use when protected item is shipped fully covered or stored under cover, as a base coat. Class 4—Contrasting intermediate coat (gray) is intended to be used only as a contrasting, intermediate coating to be applied over Type II, Class 1 material. Class 5—Top coat (white) is intended to be used only as top coating for Type II, Class 1 materials. In combination, this coating system serves to protect such items as entire aircraft, missiles, rockets, and transportation vehicles during outdoor storage and oversea deck loaded shipments. The Type III—Single Coat (exterior, white) is a single coat strippable protective coating used on items such as entire aircraft, missiles, rockets, and transportation vehicles during outdoor storage and oversea deck loaded shipments.

b. Adhering, Strippable Compounds.

(1) *MIL-C-16555.* This specification establishes the percentages of the virgin unprocessed vinyl resins, plasticizers, solution and film stabilizers, pigments, and solvents to be used in the formation of the compounds. The solvent used is methyl-ethyl-ketone (MEK) with 20 percent of toluene allowed. The specification has separate requirements for testing samples after weathering. The compounds provide waterproof protection. They should be procured ony from suppliers listed in the Qualified Products List (QPL).

(a) Application and other uses of MIL-C-16555 compounds. MIL-C-16555 compounds are applied by heavy duty spray equipment (fig 4-1). The film, 4 hours after application, must have a dry thickness of 35 to 40 mils. The first coat is applied horizontally, overlapping each pass 50 percent. The second coat is applied at right angle to the first coat. Each successive coat will be at a right angle to the previous coat until the required thickness is built up. This takes approximately seven coats. The coating will be overlapped on the adjacent metal for a distane of 2 inches. Besides their intended use as protective coatings of metal and fabric surfaces, these materials are used on vehicle preservation over Osnaburg (cotton drill) stretched on a framework to form a watershed, on engine grills, gun tubes, etc.

(b) Safety precautions. Inasmuch as MEK (methyl-ethyl-ketone) is the principle solvent used in both the cocooning and adhering, strippable compounds, a word of caution is in order as this solvent is classified as dangerous from the health and fire standpoints. (Methyl-ethyl-ketone is also known as "butanone" and is considered more toxic than acetone.)

(c) Health precautions. When spraying compounds containing MEK, the operation should be performed in well-ventilated areas to keep the vapor concentration to a minimum. The operator should wear an especially designed mask as specified in safety regulations. Smoking must not be permitted within 50 feet of the work being sprayed.

(d) Fire precautions. The vapors of MEK form flammable mixtures with the air at temperatures as low as 24°F. MEK has the property of

spontaneously igniting in the presence of oxidizers such as potassium and dichromate, sodium dichromate, chromic acid, and potassium permanganate.

(2) *MIL-C-6799.* This specification establishes the requirements for water emulsion, protective, strippable, sprayable, single or multicoat coatings for application over metallic, painted, and plastic surfaces (figure 4-1). The coatings furnished under this specification are of the following types and classes.

(c) Type I, Class 1: This material is intended for use as a single coat, interior, transparent, strippable protective coating for acrylic plastic bulk materials and assemblies containing acrylic plastics when the protected item is shipped fully covered or stored under cover. It can also be used where the protected acrylic must undergo processes of sawing, sanding, drilling, or routing.

(b) Type I, Class 2: This material is intended for use as a single coat, interior, opaque strippable protective coating for acrylic plastic bulk materials and assemblies containing acrylic plastics when the protected item is shipped fully covered or stored under cover. It can also be used where the protected acrylic must undergo processes of sawing, sanding, drilling or routing.

(c) Type II, Class 1, Black: This material is intended for use as a strippable protective coating for acrylic plastic bulk materials and assemblies containing acrylic plastics when the protected item is shipped fully covered or stored under cover; and as a basecoat for Type II, Class 5 materials.

(d) Type II, Class 4, Gray: This material is intended to be used only as a contrasting, intermediate coating to be applied over Type II, Class 1, black, basecoat material.

(e) Type II, class 5, White: This material is intended to be used only as a topcoating for Type II, Class 1 materials. In combination this protective system serves as a sprayable, strippable, protective coating for application of metallic, painted and plastic surfaces, such as: entire aircraft, missiles, rockets, and transportation vehicles during outdoor storage and overseas deckloaded shipments.

(f) Type III, White: This material is intended for use as an exterior, single coat strippable protective coating for application by spraying on plastic, painted, and metallic surfaces such as entire aircraft, missiles, rockets, and transportation vehicles during outdoor storage and oversea deck load shipment. Class 1 material or Type III is intended to provide long term protection (up to 1 year), Class 2 material is intended to offer shorter term protection (up to 6 months). The material shall have no adverse effect on the health of personnel when used for its intended purpose.

c. Standard equipment. In general, all the compounds discussed in this paragraph can be applied with the same type of spray equipment, as illustrated in figure 4-1.

4-2. Controlled Humidity

a. General. Prevention of deterioration of clean metals and organic materials, especially in the complex assemblies of modern military equipment, is often most economically attained by the elimination of excessive amounts of moisture from the storage atmosphere. The general principles set forth in this paragraph are basic to understanding dehumidifcation of storage air whether it is inside a method II pack or an oversea hutment storing prepositioned military supplies, or a large warehouse.

b. Atmospheric Air. Atmospheric air is a remarkably constant mixture of many true gases, principally nitrogen (78 percent) and oxygen (21 percent). In addition, water vapor is always mixed with atmospheric air. The actual amount of water vapor p resent in atmospheric air varies widely. For instance, there can be as much as 500 times as much water vapor actually in the air on a humid summer day in Louisiana as on a winter day in Alaska. Although temperature does not determine the amount of water vapor actually present in atmospheric air, temperature is the only factor that determines the ability to hold water vapor.

c. Relative Humidity. In storage atmosphere it is not the actual amount of water vapor present that determines effect on corrosion, rather it is the actual amount of water vapor present in relation to the maximum amount which can be held at ambient temperature. This ratio is relative humidity. Figure 4-2 illustrates what happens to relative humidity in an inclosure with a fixed amount of actual water vapor as temperature changes. With every 20°F increase in temperature, the ability of air to hold water vapor doubles and the relative humidity is cut by half. As temperature goes down, relative humidity rises approximately 50 percent for every 20°F, until it reaches 100 percent. After this, any further drop in temperature results in condensation of liquid water.

d. Relative Humidity in Storage Atmosphere. The preservation quality in dehumidified storage atmosphere is controlled in terms of relative

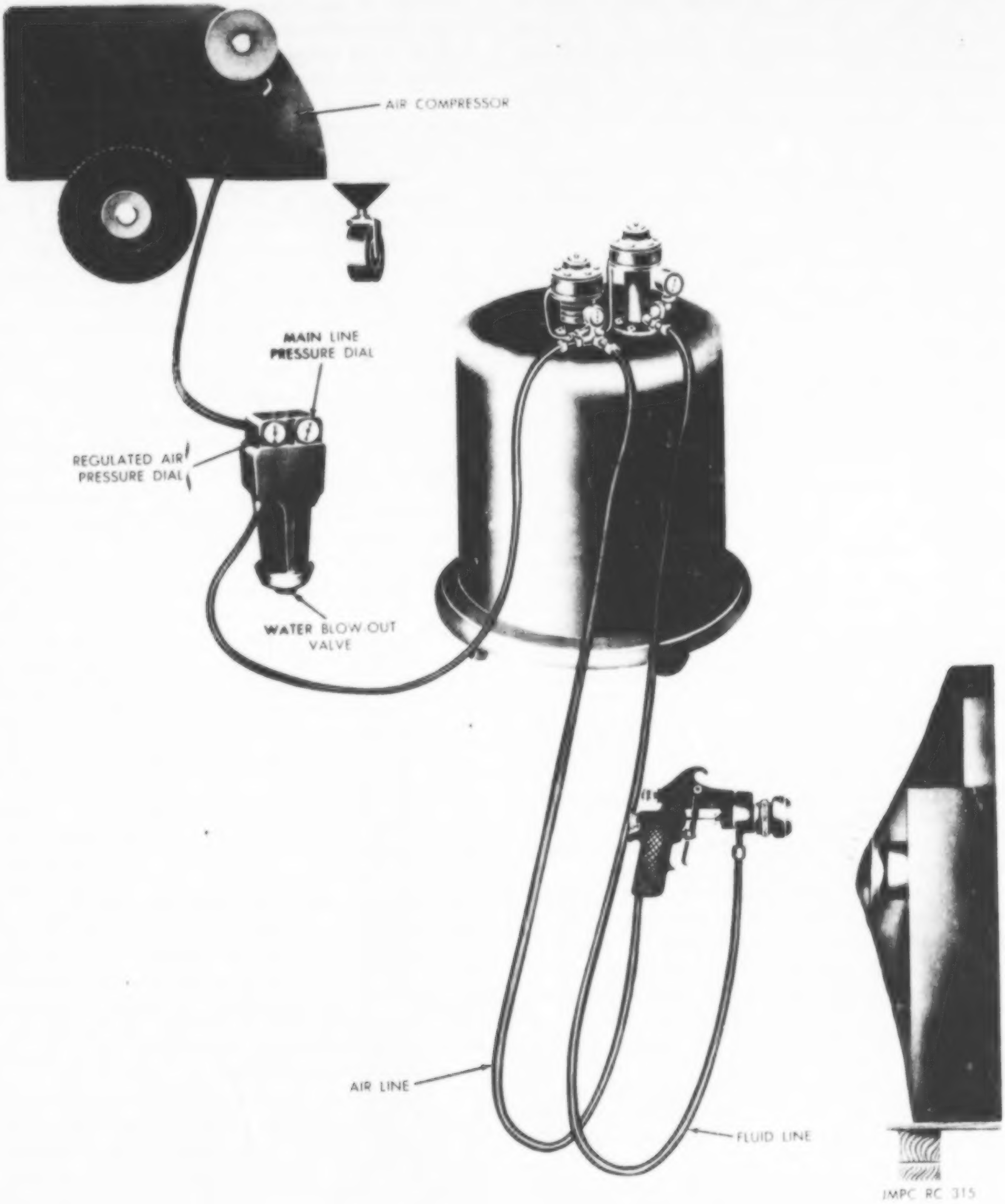

AIR COMPRESSOR
MAIN LINE PRESSURE DIAL
REGULATED AIR PRESSURE DIAL
WATER BLOW-OUT VALVE
AIR LINE
FLUID LINE
IMPC RC 315

Figure 4-1. Sprayable, strippable films equipment.

humidity. A sustained 50 percent relative humidity is the maximum considered safe for the storage of ferrous materials. Relative humidity is maintained under 50 percent in controlled humidity storage to provide a margin for the control of relative humidity increases which result from nightly temperature drops.

e. Basis for Recommended Relative Humidity Level. It has been demonstrated in laboratories that relative humidities up to 100 percent alone are not destructive to pure ferrous metals. It has been concluded that corrosive action is started when dirt, salt dusts, polluting gases, or impurities in the metal absorb moisture from the air to wet metal surfaces. Since it has been observed that this wetting action does not take place when the relative humidity is below 50 percent, maintenance of a sustained relative humidity at this level provides a "preservation" atmosphere.

f. Dust. All dusts are objectionable because of their water-absorption characteristics, but the acid dusts and salt dusts are the most destructive. Clay dusts, which are the most common, are alkaline, whereas dusts from sulfate-containing soils or from decayed organic matter are acidic. Salt dusts include sodium chloride from sea water mist, ammonium sulfate from the combustion of biuminous coal, and calcium chloride from roads which have been treated for de-icing or dust laying.

g. Humidity Control. Military publications classify methods of controlling relative humidity by removing water vapor from storage air as "static dehumidification" and "dynamic dehumidification." Relative humidity can also be controlled by heating the storage area. Descriptions and criteria for selection of these methods are as follows:

(1) *Static dehumidification.* Method II (para 3-25) provides a fixed *static* environment in a sealed water-vaporproof rated pack in which a dehumidified atmosphere is maintained by bagged desiccant. Activiated desiccant in quantities specified by MIL-P-116 can maintain an average 20 percent relative humidity even during normal temperature drops. In time, packs must be opened to replace saturated desiccant, since there is a slow but continuous transmission of water vapor through the flexible barriers used in method II.

(2) *Dynamic dehumidification.* This application deals primarily with dehumidifcation by forceable *dynamic* circulation of storage air through mechanical equipment which removes water vapor. the two types of mechanical dehumidifiers most commonly used in military applications are discussed in *h* through *n* below. The devices for controlling dehumidifiers and recording dehumidification results are described in *n* below. Generalizations which determine the suitability of various structures for dehumidification are considered in *o* below, and the storage of military equipment in controlled humidity storage is considered in *p* below.

h. Static vs. Dynamic Dehumidification. Static dehumidification is utilized in method II packs and other airtight watervaporproof rated containers. Dehumidification of such airtight containers over 5000 cubic feet, especially of nonmetal construction, is generally more economically accomplished by dynamic dehumidification. Dynamic dehumidification is accomplished in hutments, metal containers with plastic liners, ships, caves, warehouses, etc. (fig 4-3).

i. Humidity control by Heating Storage Area. In *c* above it was stated that relative humidity decreased by half with every 20°F rise in temperature. Heating the storage area may be the most economical manner of dehumidification where yearly average temperature is under 50°F, and where comfort heating is also desired. To illustrate the practical limitations of this method, after outside temperature reaches 75°F and relative humidity 75 percent, an inside temperature of over 90°F would be required to keep relative humidity at a 50-percent level. It should be noted that in static and dynamic dehumidification relative humidity is controlled by removing water vapor from the atmosphere; in heating, no water vapor is removed.

j. Dynamic Dehumidification Equipment. There are two kinds of equipment through which storage air is power-circulated to remove moisture. Paragraph *k* below, explains the flow and function of refrigeration-type equipment. Paragraph *n* explains the flow and function of the solid adsorption, i.e., desiccant bed equipment. Desiccant bed equipment is best suited to the average military dynamic dehumidification operation. Refrigeration-type equipment is suitable in warmer climates where air does not have to be cooled below 40°F to cause condensation.

k. Function of Refrigeration Dehumidification Equipment. Figure 4-4 illustrates the flow of air on through typical refrigeration dehumidifcation equipment used to remove watervapor from storage air. Storage air first passes over the cold evaporting coils (the refrigerant in the coils takes the heat it needs to vaporize out the air passing over the outside of the coils). In this process; storage air is cooled below dewpoint; causing watervapor to condense. As it drips off the evaporating coils; it is drained out of the storage

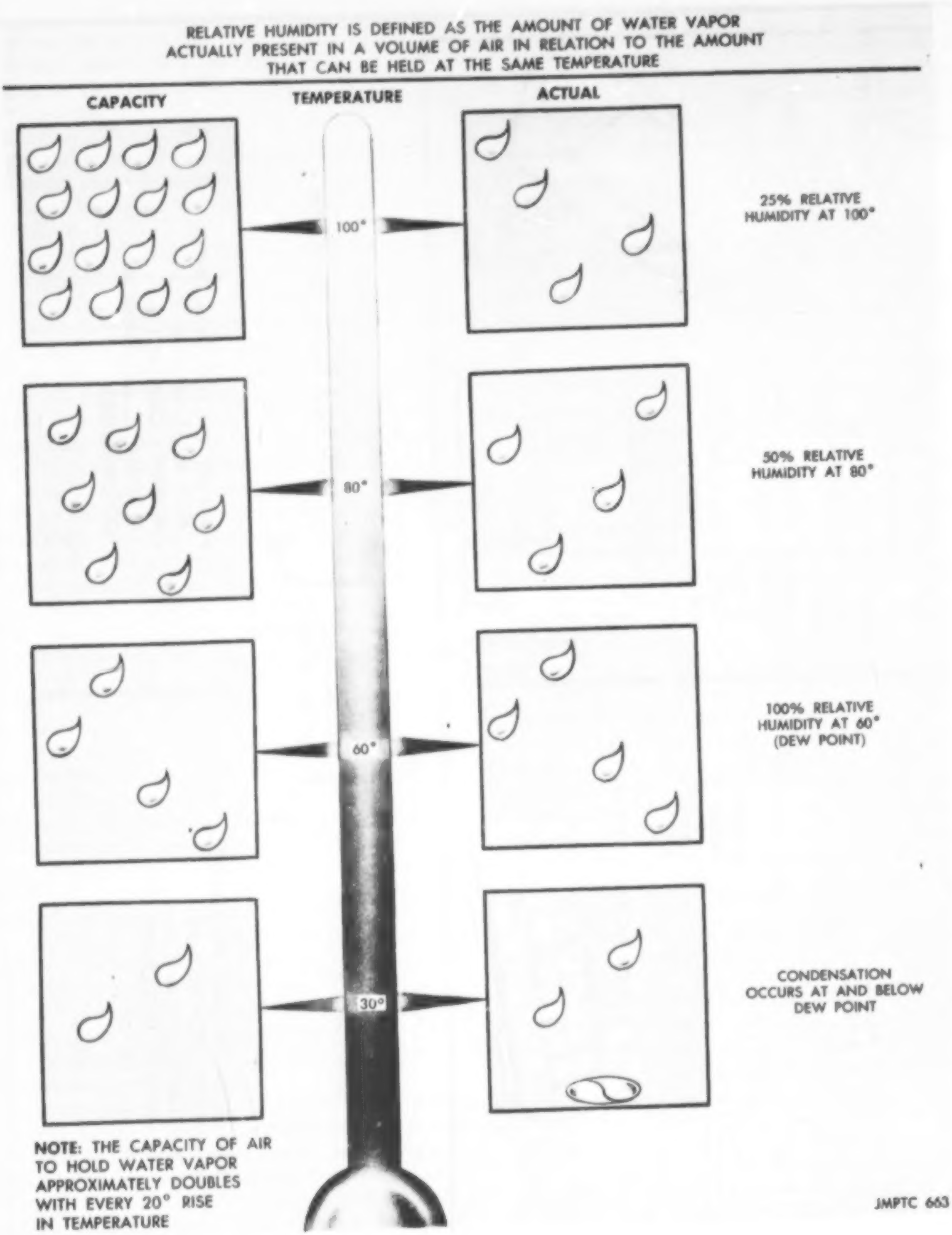

RELATIVE HUMIDITY IS DEFINED AS THE AMOUNT OF WATER VAPOR ACTUALLY PRESENT IN A VOLUME OF AIR IN RELATION TO THE AMOUNT THAT CAN BE HELD AT THE SAME TEMPERATURE
CAPACITY
TEMPERATURE
ACTUAL
100°
25% RELATIVE HUMIDITY AT 100°
80°
50% RELATIVE HUMIDITY AT 80°
60°
100% RELATIVE HUMIDITY AT 60° (DEW POINT)
30°
CONDENSATION OCCURS AT AND BELOW DEW POINT
NOTE: THE CAPACITY OF AIR TO HOLD WATER VAPOR APPROXIMATELY DOUBLES WITH EVERY 20° RISE IN TEMPERATURE
JMPTC 663

Figure 4-2. Temperature and relative humidity relationship.

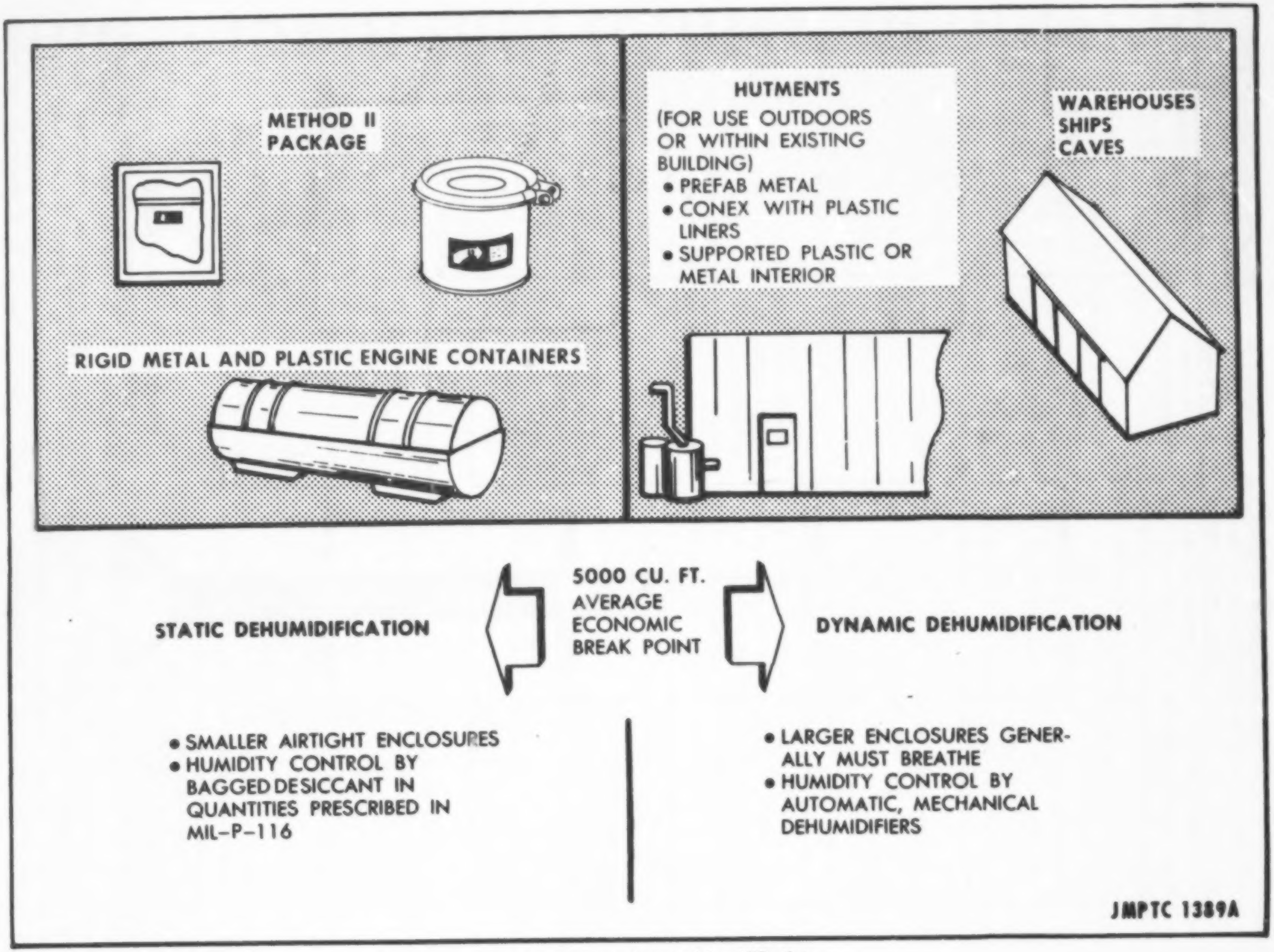

METHOD II PACKAGE
RIGID METAL AND PLASTIC ENGINE CONTAINERS
HUTMENTS
(FOR USE OUTDOORS OR WITHIN EXISTING BUILDING)
• PREFAB METAL
• CONEX WITH PLASTIC LINERS
• SUPPORTED PLASTIC OR METAL INTERIOR
WAREHOUSES
SHIPS
CAVES
STATIC DEHUMIDIFICATION
5000 CU. FT. AVERAGE ECONOMIC BREAK POINT
DYNAMIC DEHUMIDIFICATION
• SMALLER AIRTIGHT ENCLOSURES
• HUMIDITY CONTROL BY BAGGED DESICCANT IN QUANTITIES PRESCRIBED IN MIL-P-116
• LARGER ENCLOSURES GENERALLY MUST BREATHE
• HUMIDITY CONTROL BY AUTOMATIC, MECHANICAL DEHUMIDIFIERS
JMPTC 1389A

Figure 4-3. Static vs. dynamic dehumidification.

area. The limitation of this method of dehumidification can be seen at this point. If the air has to be cooled below 40°F to reach its dewpoint; frosting of the coils tends to make this process uneconomical.

NOTE

> A mechanically refrigerated, self-contained, space dehumidifier is procured for Naval shipboard use under specification MIL-D-19947.

l. Necessity to Reheat Storage Air. An apparent contradiction appears in figure 4-4 in that the storage air, after passing over the cold evaporating coils where water vapor was condensed; now has a higher relative humidity than when it entered the dehumidifier. This is because the ability of air to hold watervapor decreases approximately one half with every 20°F drop of temperature (c above). At this point, the storage air in the equipment has less actual humidity but more relative humidity than when it entred. By passing this air over the condensing coils of the dehumidifier (which are warm like the coils on the back of a refrigerator), the air is warmed and realtive humidity drops well below the original level. Since this form of dehumidification is best suited for warm climates; there is a tendency to place the condensing coils outside the storage area. This results in comfort cooling, but may actually increase the relative humidity in the storage area.

m. Function of Solid Adsorption (Desiccant) Dehumidifiers. The basis for this method of dehumidification is the surface attraction of watervapor by granular materials known as desiccants which have tremendous microscopic surface area. Materials such as silica gel or alumina can adsorb 40 percent of their weight in moisture without undergoing physical or chemical change. The key to the use of these materials is that the adsorbed moisture can be vaporized by heating saturated desiccant to about 300°F. This "reactivation" process is accomplished in method II packaging by removing and placing bagged desiccant in an oven. It is accomplished automatically in mechanical dehumidifiers.

(1) *Single and dual bed machines.* Figure 4-5 pictures a typical solid adsorption machine. It has two beds or two chambers which hold desiccant, plus a relatively simple arrangement of air ducts; blowers, filters, air valves, heaters, and controls. Smaller capacity single bed machines are available. These cannot provide a constant supply of dehumidified air since the same desiccant bed must be cycled to dehumidify and to be reactivated. These two phases are carried on simultaneously in dual bed machines (fig 4-6).

(2) *Dehumidification cycle.* Refer to the adsorbing desiccant bed on the righthand side of figure 4-8. Notice position of cycling valves. Storage air is simply brought through intake and filter, power circulated by blower through the activated desiccant bed; and returned to storage area.

(3) *Reactivation cycle.* Refer to the reactivating desiccant bed on the lefthand side of figure 4-6. Notice position of cycling valves. Outside weather air is ducted to the machine, filtered, power circulated by blower over heaters which raise the temperature to approximately 300°F, through the desiccant, and returned to the outside. A thermometer in the duct returning the reactivation air to the outside provides a check for cycling time setting. When the temperature rises noticeably, the heat is no longer being used to volatize moisture adsorbed on the desiccant, and the automatic timer setting should cause the cycling valves to turn, thereby reversing desiccant bed cycles.

(4) *Installation of machines.* Solid desiccant machines can be installed either inside or outside the dehumidified space. If either case, it is necessary to run two separate air ducts through the walls of the inclosure. When installed inside, the duct lines bring in and discharge outside weather air used in reactivation. When installed outside, the ducts bring and return storage air from the inclosure. Location of machine, inside or outside, should be so that dry air is returned to the coldest part of the dehumidified space (where relative humidity is the highest). Floor space in hutments is generally saved by outside installation. In some instances, installation of machines from suspended platforms has saved floor space in warehouses.

(5) *Equipment.* Continuous duty, automatic desiccant dehumidifiers having capacities up to 15,000 cubic feet per minute may be procured under specification MIL-D-16886. These machines may be ordered for reactivation by electric, steam, or gas heat. Bulk desiccant to replace dirty or accidentally scorched material is obtainable under Specification MIL-D-3716.

n. Control and recording equipment. Economical human hair element humidistats are generally used in military applications to control the on-off operation of dehumidification equipment. A continuous relative humidity and temperature record is usually provided by a recorder (fig 4-7). Because of the unpredictability of the calibrations of these instruments, their accuracy is periodically checked with a psychrometer and a psychrometric

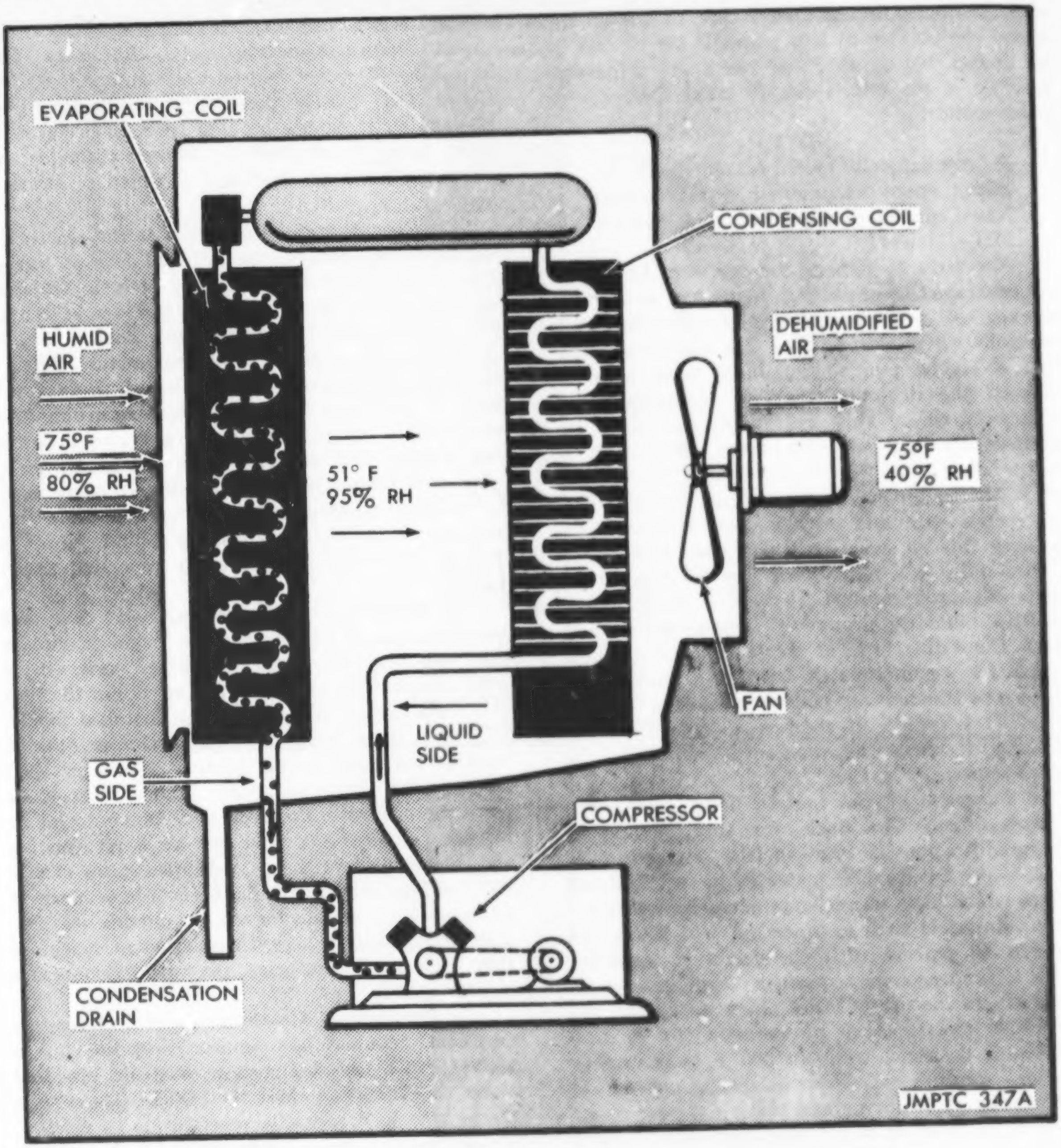

EVAPORATING COIL
CONDENSING COIL
HUMID AIR
DEHUMIDIFIED AIR
75°F
80% RH
51° F
95% RH
75°F
40% RH
FAN
LIQUID SIDE
GAS SIDE
COMPRESSOR
CONDENSATION DRAIN
JMPTC 347A

Figure 4-4. Flow diagram—mechanically refrigerated dehumidifier.

table. These devices operate as follows:

(1) *Humidity and temperature recording device.* A continuous 7-day temperature and relative humidity recording device known as a hygrothermograph provides a weekly record of the quality of the dehumidified atmosphere being furnished, and is also useful in adjusting the timing of the desiccant bed cycles. In this machine, two pens mark a spring-driven chart that makes one revolution each week. A human hair element moves one of the pens to record relative humidity; a bimetallic temperature element moves the other pen to record temperature. When either humidistats or hygrothermographs are removed from dehumidified inclosures to be checked, they should be carried in a box containing desiccant as

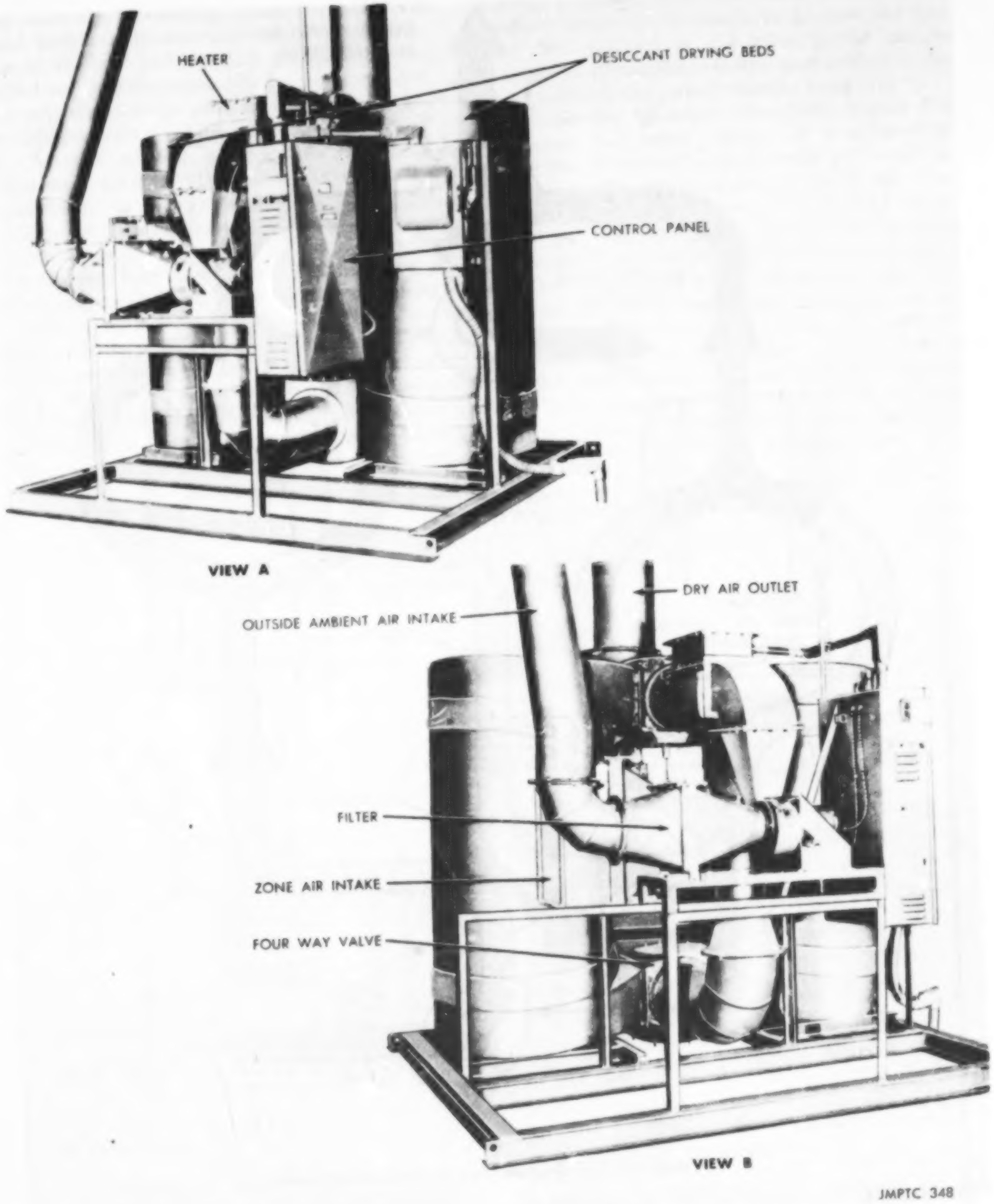
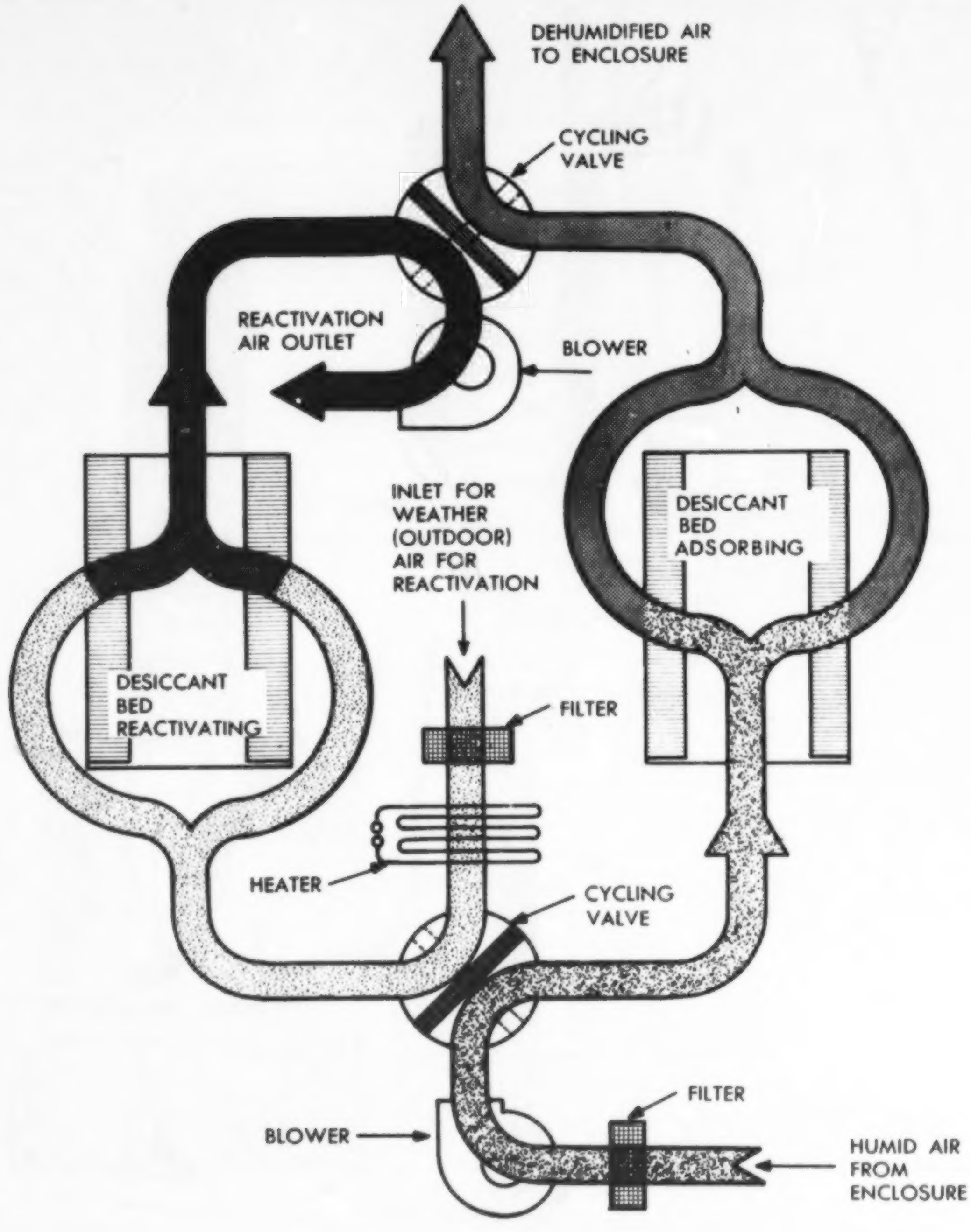

HEATER
DESICCANT DRYING BEDS
CONTROL PANEL
VIEW A
DRY AIR OUTLET
OUTSIDE AMBIENT AIR INTAKE
FILTER
ZONE AIR INTAKE
FOUR WAY VALVE
VIEW B
JMPTC 348

Figure 4-5. Typical dual bed desiccant dehumidifier.


DEHUMIDIFIED AIR
TO ENCLOSURE
CYCLING
VALVE
REACTIVATION
AIR OUTLET
BLOWER
DESICCANT
BED
ADSORBING
INLET FOR
WEATHER
(OUTDOOR)
AIR FOR
REACTIVATION
DESICCANT
BED
REACTIVATING
FILTER
HEATER
CYCLING
VALVE
FILTER
BLOWER
HUMID AIR
FROM
ENCLOSURE

JMPTC 346 A

Figure 4-6. Flow diagram—dual bed desiccant dehumidifier.

the humidity in outside *weather* air would cause the human hair element to elongate and might put the devices out of calibration.

(2) *Instrument checking.* Humidistats and hygrothermographs are usually exchanged for fresh ones and taken to a test bench at least every 2 months. A standard method of obtaining a true relative humidity reading to check these devices is to use a *psychrometric chart.* There are vertical and horizontal lines on this chart for dry bulb temperatures and the difference between dry bulb and wet bulb temperatures. Curved lines

which cross the intersection of appropriate vertical and horizontal lines indicate relative humidity. Accurate dry bulb and wet bulb temperatures are provided by an instrument called a psychrometer. The type psychrometer used for this purpose has a centrifugal blower which fans two thermometers; one with a wick wetted bulb. The sling psychrometer used by the military to determine the feasibility to troop training on hot humid days does not give accurate wet bulb readings in dehumidified air.

(3) *Human hair humidistat.* The humidistat element consists of one or more bundles of human hair, from 3 to 8 inches long. These hairs are clamped at both ends into yokes: attached to the yokes are multiplying linkages and levers which move a contact in a switch. As the relative humidity of the storage atmosphere increases, the hairs elongate, thereby closing a circuit to turn the machine on when the relative humidity reaches a preset level. The hairs shrink as the relative humidity decreases, to reverse the process. The position of the pivot points can be changed to adjust the instrument if contact is not being made at the correct relative humidity.

o. Controlled Humidity Structures. Figure 4-5 illustrates the wide variety of structures or inclosures which can be dynamically dehumidified. This paragraph will generalize on the factors that may determine the amount of watervapor which must be removed daily from any suitable inclosure. These factors will be considered under the two avenues of entry watervapor (fig 4-8); first, daily entry of watervapor accompanying air from the outside known as *infiltration*, and second, daily entry of watervapor passing directly through construction materials know as *transmission*. Also considered is a third source of daily *load* for dehumidification equipment—the moisture contained in packing materials and skids.

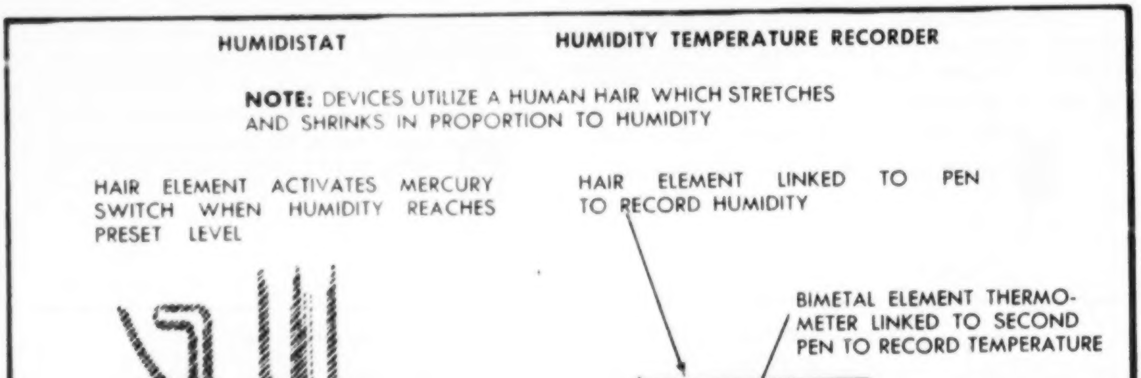

HUMIDISTAT
HUMIDITY TEMPERATURE RECORDER
NOTE: DEVICES UTILIZE A HUMAN HAIR WHICH STRETCHES AND SHRINKS IN PROPORTION TO HUMIDITY
HAIR ELEMENT ACTIVATES MERCURY SWITCH WHEN HUMIDITY REACHES PRESET LEVEL
HAIR ELEMENT LINKED TO PEN TO RECORD HUMIDITY
BIMETAL ELEMENT THERMOMETER LINKED TO SECOND PEN TO RECORD TEMPERATURE
HUMIDISTAT SHOWN MOUNTED ON CONTROL PANEL OF DEHUMIDIFIER
DATA COLLECTION ON REVOLVING CHART PERMITS WEEKLY ANALYSIS OF QUALITY OF PRESERVATION ATMOSPHERE
JMPTC 1385

Figure 4-7. Relative humidity control and recording devices.

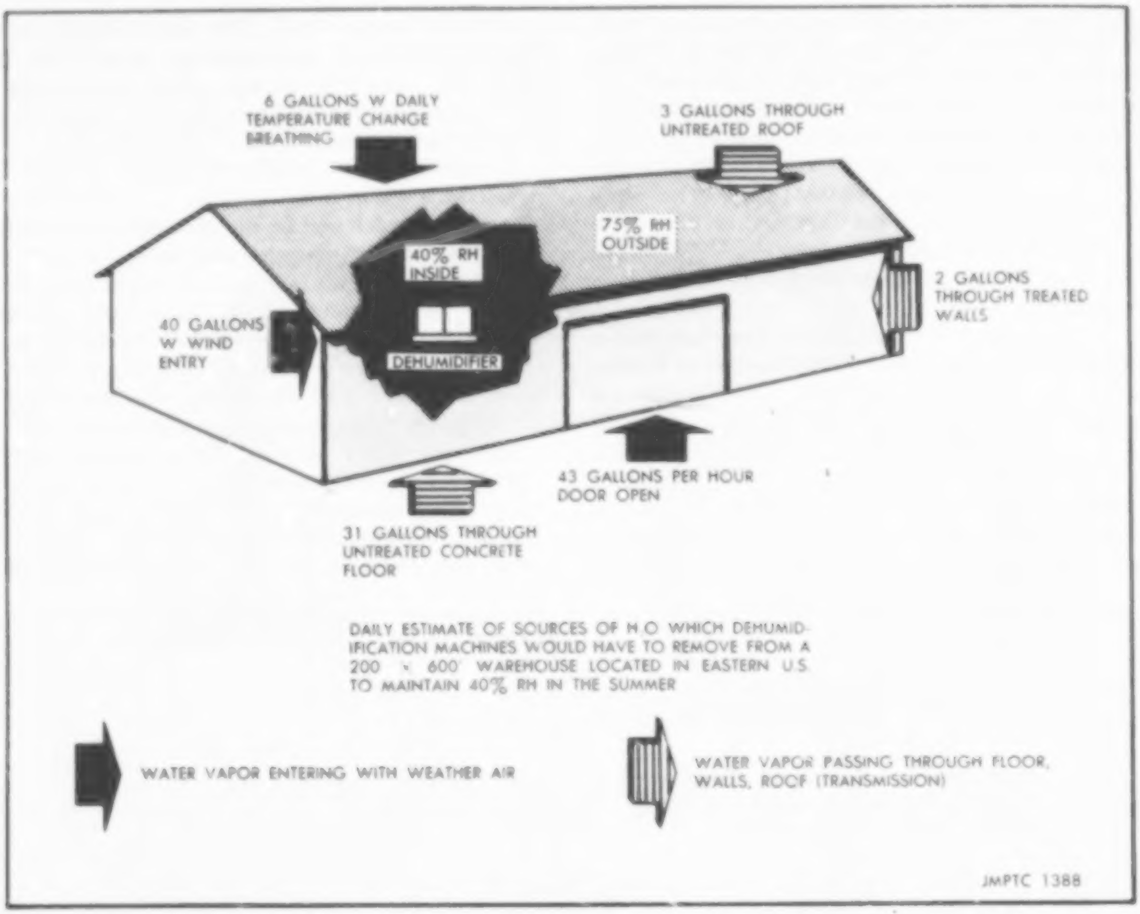

6 GALLONS W DAILY TEMPERATURE CHANGE BREATHING
3 GALLONS THROUGH UNTREATED ROOF
75% RH OUTSIDE
40% RH INSIDE
2 GALLONS THROUGH TREATED WALLS
40 GALLONS W WIND ENTRY
DEHUMIDIFIER
43 GALLONS PER HOUR DOOR OPEN
31 GALLONS THROUGH UNTREATED CONCRETE FLOOR
DAILY ESTIMATE OF SOURCES OF H₂O WHICH DEHUMIDIFICATION MACHINES WOULD HAVE TO REMOVE FROM A 200' × 600' WAREHOUSE LOCATED IN EASTERN U.S. TO MAINTAIN 40% RH IN THE SUMMER
WATER VAPOR ENTERING WITH WEATHER AIR
WATER VAPOR PASSING THROUGH FLOOR, WALLS, ROOF (TRANSMISSION)
JMPTC 1388

Figure 4-8. Example of daily watervapor load in a dehumidifed warehouse.

(1) *Infiltration*. Controlled humidity storage structures should be caulked and closed tighter than normal structures to preent infiltration of weather air and, if in active use, door openings must be rigidly controlled to prevent mass entry of weather air. However, structures must not be too tight or they might explode as inside air warms with sun of the roof. This necessary inward and outward flow of air through cracks and crevices with temperature changes is called *breathing*. To accommodate breathing, specifications for suitability of outside structures for controlled humidity storage permit up to one complete turnover of air each 24 hours in a test where internal air pressure is raised to a point which is equal to a wind coming at the structure from the outside at 14 m.p.h. For comparison, maintenance of similar pressure conditions in an unprepared warehouse or ordinary factory building would produce 60 complete turnovers of air in 24 hours.

(2) *Transmission*. The walls, roof, and floor of structures may be sealed with polyethylene, aluminum foil, paint, biuminous coating, or mastic topping to reduce water-vapor transmission. Although air pressure remains the same on the outside as on the inside of a controlled humidity structure, there will be a great difference in watervapor pressures. Watervapor will leave outside air and pass directly through building materials to get to the area of lower watervapor pressure inside. In determining the suitability of structures for controlled humidity storage, daily load from watervapor transmission is estimated on the basis of the permeability of construction materials, their thicknesses and sealing.

(3) *Dehumidification load from storage*. In controlled humidity structures in active use, it has been estimated that 5 percent of the daily load of moisture which must be removed by dehumidifying machines results from drying out new storage. For instance, wood boxes and skids probably lose 7 percent of their weight in drying out. Once wood has been "brought down" in moisture content, it is a stabilizing factor in maintaining an even level of controlled humidity.

p. Application of Controlled Humidity Storage. The cost of providing preservation air through dynamic dehumidification has to be justified in the utilization of this type of storage. Some of the advantages and implications are as follows:

(1) *Commercially packed material.* Military supplies which have been packaged commercially are protected by corrosion control methods which are consistent only with limited tenure of storage; however, the supplies so protected may be stored indefinitely in controlled humidity storage.

(2) *Level A and Level B—packed material.* The more extensive corrosion control provided by levels A and B is extended in controlled humidity storage. *For example,* where desiccant in a Method II package might have to be replaced after extended conventional storage, it would probably still be near the beginning of its effective condition after extended controlled humidity storage. Periods between cyclic ispections may be lengthened for all levels of packing.

(3) *Packing containers.* If wood shipping containers are included in controlled humidity storage it should be borne in mind that they may be weakened by splitting around nails as shrinkage occurs. Strapping applied to wood shipping containers before controlled humidity storage will loosen as shrinkage occurs, usually to the point where it must be replaced before shipment.

(4) *Machinery and equipment.* Complicated machinery and heavy equipment, protected only by light oils and dust covers which permit the item to be readied for use without disassembly and removal of heavy preservatives, can be stored for indefinite periods of time in controlled humidity storage.

(5) *Prepositioned material.* There is a growing requirement for the indefinite storage of military supplies in prepositioned oversea locations and floating depots. This material can be maintained in nearly ready-for-issue condition in controlled humidity inclosures.

(6) *Work in controlled humidity atmosphere.* Working conditions, so far as the extent of dehumidification required for storage, may be considered desirable. Drier climates in the southwest are sought for their healthfulness. Reluctance of some operators to work in dehumidified areas may be due to experiences with dangerous concentrations of fumes from internal combustion forklifts which would have occurred in any warehouse where doors cannot be left open.

CHAPTER 5

FIBERBOARD AND PAPERBOARD CONTAINERS

5-1. Introduction

a. Containers are required in several of the MIL-P-116 preservation methods—two of these methods specify a container-barrier-container combination. MIL-P-116 allows the procuring agency to specify supplementary cartons, boxes, or other suitable containers with any method of unit protection to facilitate storage, handling, and packing.

b. MIL-P-116 does not require containers which conform to any particular specification for the purposes stated in *a* above. The most common containers are Box Fiberboard (PPP-B-636) (para 5-2); Boxes, Folding, Paperboard (PPP-B-566) (para 5-4); Boxes, Set-Up, Paperboard (PPP-B-676) (para 5-5); Boxes, paperboard, Metal-Stayed (PPP-B-665) (para 5-6).

5-2. Fiberboard Boxes (PPP-B-636)

a. General. A fiberboard box is a container made of one or more pieces of corrugated or solid fiberboard. The pieces are creased, slotted, joined, and folded according to standard styles described in Specification PPP-B-636 and illustrated in figures 5-3 and 5-4. In *b* below the advantages of these boxes are considered as interior containers; *c* reviews the specification classification of these containers. Understanding of the types, classes, varieties, grades and styles is necessary to economically utilize the combinations of characteristics offered by these boxes. Fiberboard materials are described in *d* below; *e* and *f* provides the basis for the selection of fiberboard; *g* describes the standard styles of boxes into which the selected material can be fabricated, sleeves and liners are covered in *h* and *i*; *j* explains fabrication, with emphasis on requirements for securing the manufacturer's joint; *l* discusses methods of closure; and *m* discusses methods of waterproofing fiberboard boxes. The use criteria, closure, and reinforcing requirements in PPP-B-636 are primarily oriented toward exterior shipping container usage. Some of this information is included in this paragraph for reference purpose since, because of their characteristics, fiberboard boxes may be used as shipping containers during part of their supply line life. Other PPP-B-636 use information such as reinforcement (banding) may be found in TM 38-230-2.

b. Advantages. PPP-B-636 fiberboard boxes offer the following advantages for use as interior packaging containers:

(1) Two types of fiberboard (corrugated or solid) provide for a more rigid or a more resilient container. A second variety of domestic corrugated board is double-walled to provide more strength and cushioning.

(2) Two classes of fiberboard provide for low cost domestic shipping containers or more expensive *wet strength* containers.

(3) A wide range of fiberboard grades (strength) allows economical application in a wide range of items of several weights and sizes.

(4) Various box styles (design) are available for the combination of type, variety, class, and grade of fiberboard selected. The regular slotted box is standard. It can be procured in as small a size as 4 x 4 inches for unit packing.

(5) Prefabricated boxes are procured with only the *manufacturer's joint* stitched for flat shipment and storage. Assembly and closure are easy.

(6) Hand-operated and automatic box making machines are available when local custom production from sheet stock is justified. Such equipment facilitates making economical nesting fits for container-barrier-container packs.

(7) Interior pack marking can be neatly applied by practically all approved methods. Production methods such as printing, lithographing, silk-screening, and photo marking should be considered at time of ordering boxes for large runs.

(8) Unit or intermediate containers in bin storage are usually suitable for parcel post shipment without overpacking.

c. Classification of Fiberboard Boxes. Fiberboard boxes, for domestic and oversea shipments, have been consolidated under Specification PPP-B-636. Fiberboard material must conform to Specification PPP-F-320. Boxes may be procured or fabricated in the following types and classes:

(1) *Type (fig 5-1).*

(*a*) *Type CF boxes.* Type CF boxes are fabricated from corrugated fiberboard (CF) stock (*d* below). Domestic corrugated is of two varieties—

1. SW variety is single-wall construction.

2. DW variety is double-wall construction.

(*b*) *Type SF boxes.* Type SF boxes are fabricated from solid fiberboard (SF) stock (*d* below).

(2) *Classes.*

(*a*) *Classic domestic.* Domestic class boxes are intended for domestic shipments and can be made to

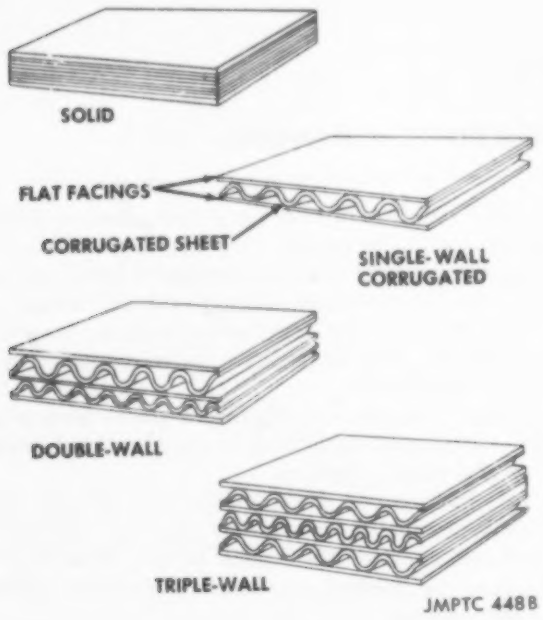


Figure 5-1. Types and varieties of fiberboard.

meet either normal or special requirements. Under normal requirements, the boxes are used as single-trip containers and no multiple shipments are involved. Under special requirements, the boxes are used where more hazardous storage and shipping conditions are expected.

(*b*) *Class weather-resistant.* Weather resistant boxes are intended for oversea shipments and can also be made to meet either normal or special requirements. Under normal requirements, the boxes are used as single-trip containers and no multiple shipments are involved. Under special requirements, the boxes are used where more hazardous storage and shipping conditions are contemplated.

(*c*) *Class waterproof and watervapor resistant (WWVR).* These containers are intended for use where waterproofness and resistance to the penetration of watervapor are required. Otherwise, intended use is the same as for class weather resistant containers.

(3) *Grades of fiberboard.* Different strengths of fiberboard are indicated as grades.

(*a*) Domestic grades of fiberboard, types CF and SF, are differentiated by p.s.i. (pounds per square inch) of bursting strength.

(*b*) Weather-resistant grades of fiberboard are differentiated by a letter-number combination such as V2, V3, V4, W5 and W6 which represent different bursting strengths. The numeral in such combination represents the grade of material and the letter in each combination represents a kind of fiberboard (V- or W-board). W-board is a lower strength, highly weather-resistant board.

1. Type CF (corrugated fiberboard can be obtained as follows: (The small "c" indicates corrugated fiberboard)

(a) *Weather resistant singlewall*—grades 3, 5 and 6 with compliance symbols V3c, W5c and W6c.

(b) *Weather resistant doublewall*—grades 11, 13 and 15, with compliance symbols V11c, V13c and V15c.

(c) *Waterproof and watervapor resistant singlewall*—grades 3 and 5, with compliance symbols V3c WWVR and W5c WWVR.

(d) *Waterproof and watervapor resistant doublewall*—grade 11 and 13, with compliance symbols V11c, WWVR and 13c WWVR.

2. Type SF (solid fiberboard), can be obtained in grades 2, 3, 4, 5 and 6 with compliance symbols of V2s, V3s, V4s, W5s, and W6s. The small s indicates solid fiberboard.

d. Materials.

(1) *Corrugated fiberboard, type CF.* Corrugated fiberboard is fabricated of flat sheets of paperboard (called facings) glued to the crowns of a corrugated sheet. Strength requirements are obtained by varying caliper, number, and quality of the component facings and the corrugated medium. Corrugated fiberboard has low resistance to puncture but affords a high degree of resilience and cushioning. Double wall, DW, corrugated fiberboard consists of three flat facings and two corrugated sheets in the following sequence: a facing, a corrugated sheet, a (center) facing, a corrugated sheet, and a facing. It is this combination of flat and corrugated sheets that gives corrugated fiberboard its qualities of strength and resilience. Corrugated fiberboard is constructed with different kinds and arrangements of flutes. A flute, with 36 plus or minus 3 flutes per linear foot, is generally used where stacking strength must be provided by the box. B flute, with 50 plus or minus 3 flutes per linear foot, is used where the contents that support the box are of low fragility. C flute, with 42 plus or minus 3 flutes per linear foot, can be made to serve either purpose (fig 5-2).

(*a*) *Domestic fiberboard boxes.* Variety SW fiberboard used to fabricate type CF boxes will be A, B, or C flute at the option of the supplier. Variety DW fiberboard used to fabricate type CF boxes will be any combination of A, B, or C flutes, except BB. Type CF boxes, fabricated from variety SW or DW fiberboard shall have the flutes running perpendicular to the scores of the box openings. When specified, the flutes for variety SW or DW fiberboard will run horizontal to the scores of the box openings for boxes of a size that the top and bottom openings are on the smallest panels.

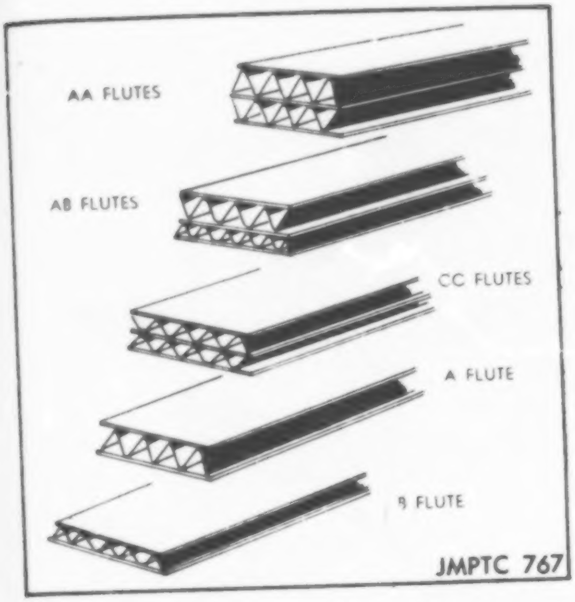


Figure 5-2. Corrugated fiberboard flutes.

(*b*) *Weather resistant and waterproof and watervapor resistant fiberboard boxes.* SW fiberboard used to fabricate type CF boxes will be B or C flute, and the flutes will run perpendicular to the scores of the box openings. When specified, the flutes for variety SW fiberboard will run horizontal to the score lines of the box opening for boxes of such size that the top and bottom openings are on the smallest panels.

(2) *Solid fiberboard, Type SF.* Solid fiberboard consists of several sheets or plies of paperboard laminated together with an adhesive applied over the entire area of contact between the sheets (fig 5-1). The paperboard may be sheets of chipboard between two outer sheets of kraft or jute, or all sheets may be of jute or kraft. The combined material is solid, hard, and rigid, and boxes fabricated from it resist puncture to a high degree but offer little cushioning to their contents. They do however, offer greater resistance to rough handling and wear, and are better adapted for use in shipping heavier and less fragile items than those shipped in corrugated fiberboard boxes. The thickness of the fiberboard will depend upon the number of plies used in its construction. If the weight of the box and contents does not exceed 40 pounds, the fiberboard will be not less than two-ply. If the weight exceeds 40 pounds, the fiberboard will be not less than three-ply.

e. Uses and Limitation of Class Domestic Fiberboard Boxes. The uses of fiberboard boxes for domestic shipments are essentially as indicated in c(2) above. Many variations of special die-cut inserts, scored pads, and partitions can be fabricated to give additional protection to the item. Table I of Specification PPP-B-636 is used to determine the applicable requirements when class domestic fiberboard boxes are needed. The first two columns of this table are for normal and special requirements. The sub-columns give the maximum total inside dimensions. The normal requirements column is used for single trip containers; the special requirements column applies to multiple or hazardous shipments. The columns for corrugated and solid fiberboard (CF and SF) show the minimum bursting strength of the fiberboard in pounds per square inch which determines the grades.

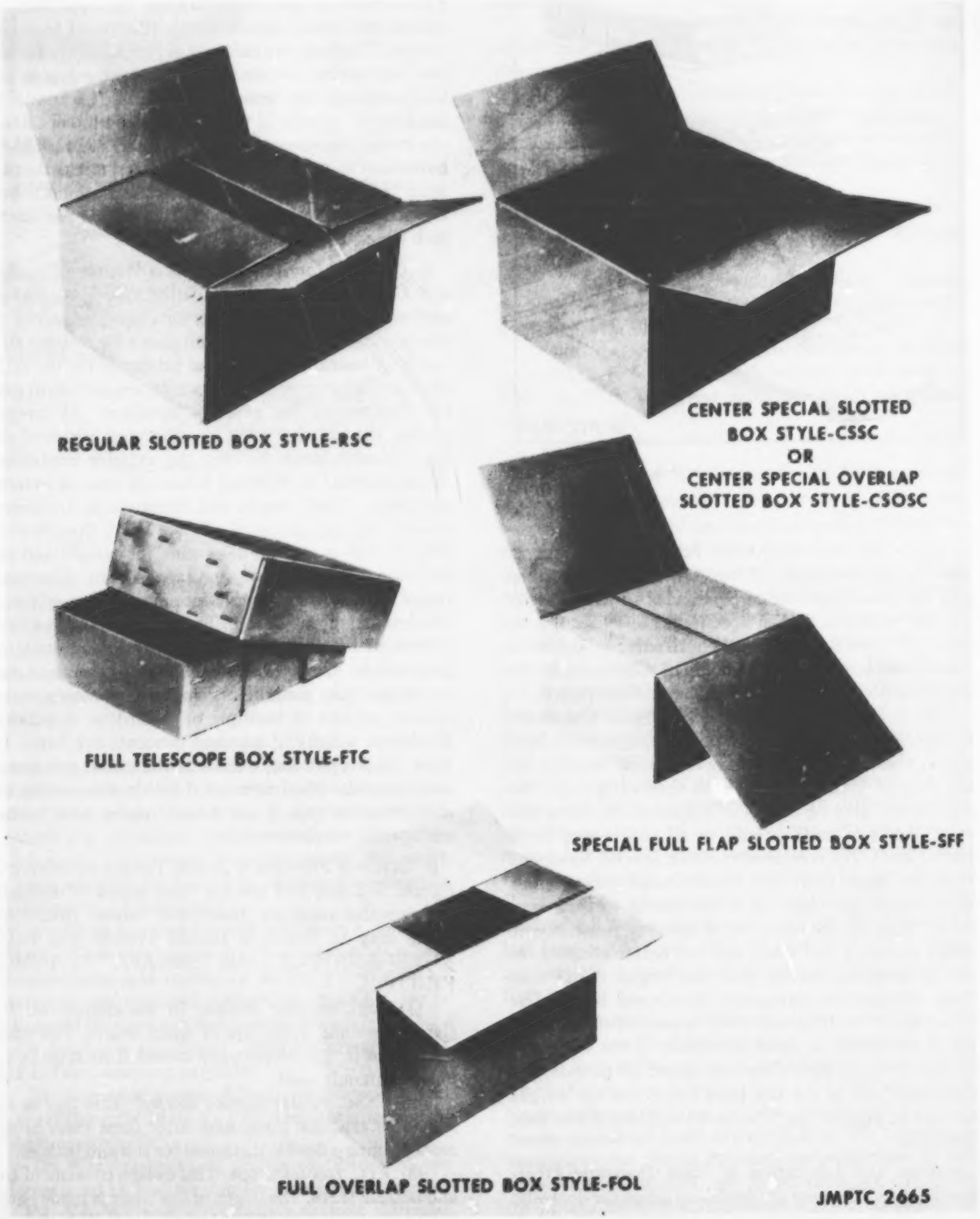
f. Uses and Limitations of Class Weather Resistant and Class Waterproof and Watervapor Resistant Fiberboard Boxes. V-board was developed primarily for the fabrication of exterior containers for oversea shipment. W-board was developed primarily for the fabrication of interior containers which are packed in exterior containers for oversea shipment. At oversea points, the exterior pack is sometimes removed and the W-board boxes become the exterior containers. When V-board or W-board boxes are used as exterior containers, their weight and dimensional limitations should not be exceeded. Table II of Specification PPP-B-636 is used to determine the weight and size limitation when class weather-resistant fiberboard boxes are required. Compliance symbols are given in the first column: V1s, etc. The remainder of the table is divided into *Normal requirements and Special requirements.* The normal requirements column is used for single trip containers; the special requirements column applies to multiple or hazardous shipments. Maximum weight of box and contents are listed for type 1 and type 2 loads under both normal and special requirements. Maximum total inside dimensions are also given for type 1 and 2 loads under both normal and special requirements.

g. Styles of Fiberboard Boxes. The styles covered in figures 5-3 and 5-4 are the basic styles of domestic and weather-resistant fiberboard boxes. Additional styles may be found in DLAM 4145.2, Vol. II/TM 38-230-2/NAVSUP Pub 503/AFP 71-16/MCO P4030.31A.

(1) *RSC, regular slotted.* In the design, all the flaps (inner and outer) are of equal length. The outer flaps meet in the center when closed. This style is the most commonly used.

(2) *CSSC, center special slotted.* This box is designed so that the inner and outer flaps meet in the center giving a double thickness for top and bottom.

(3) *FTC, full telescope.* This design consists of top and bottom trays. The depth of the cover is made equal to the overall depth of the bottom tray. This style of box, when closed, has a triple thickness of fiberboard on all four corners, affording good stacking strength.



REGULAR SLOTTED BOX STYLE-RSC

CENTER SPECIAL SLOTTED BOX STYLE-CSSC OR CENTER SPECIAL OVERLAP SLOTTED BOX STYLE-CSOSC

FULL TELESCOPE BOX STYLE-FTC

SPECIAL FULL FLAP SLOTTED BOX STYLE-SFF

FULL OVERLAP SLOTTED BOX STYLE-FOL

JMPTC 2665

Figure 5-3. Styles of fiberboard boxes (1).

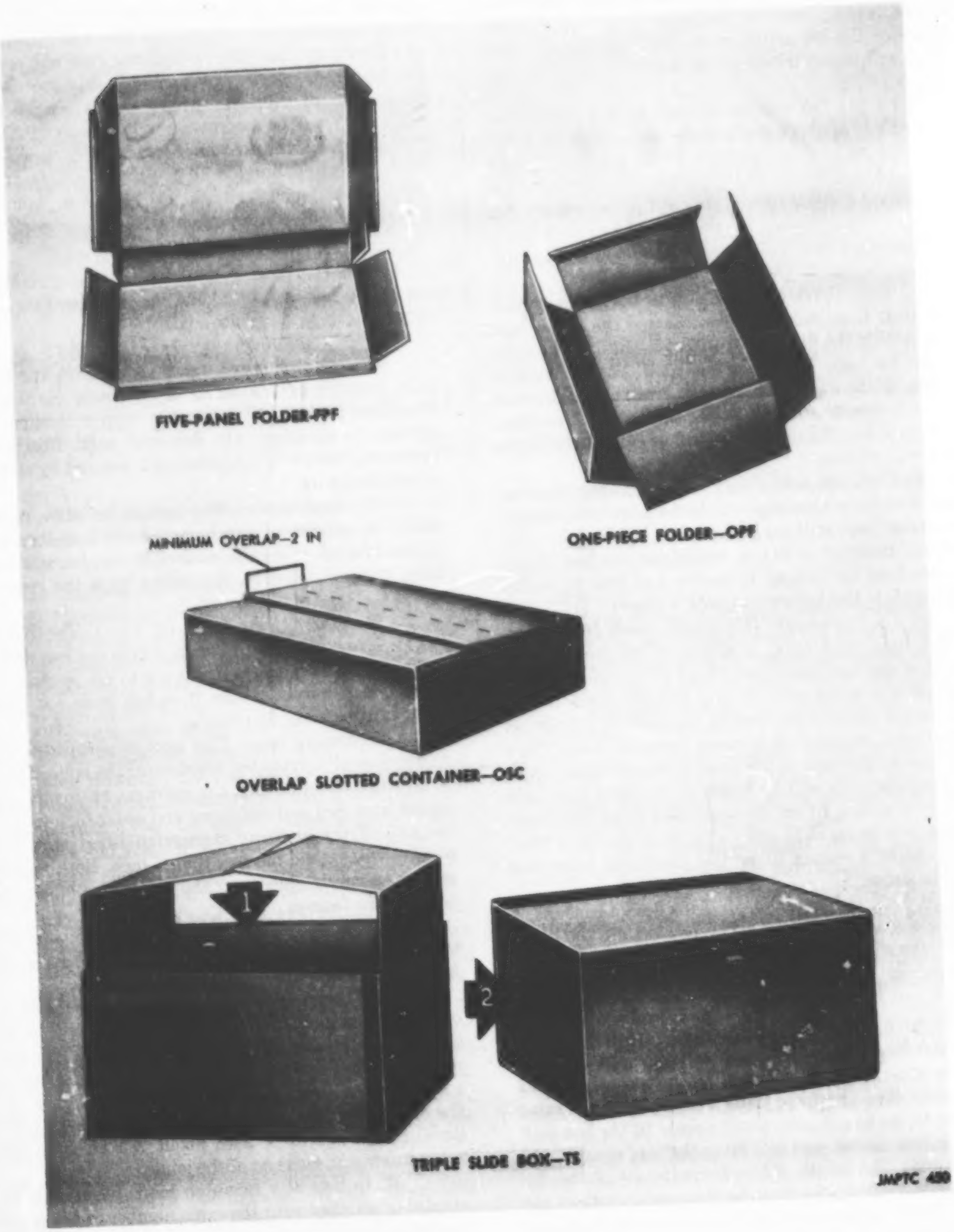

FIVE-PANEL FOLDER-FPF
ONE-PIECE FOLDER—OPF
MINIMUM OVERLAP—2 IN
OVERLAP SLOTTED CONTAINER—OSC
1
2
TRIPLE SLIDE BOX—TS
JMPTC 450

Figure 5-4. Styles of fiberboard boxes (2).

(4) *SFF, special full flap slotted.* In this design, the outer flaps fully overlap while the inner flaps meet in the center, resulting in triple thickness of fiberboard on the top and bottom. The length of the outer flaps will be not less than the inside width of the box minus 1 inch.

(5) *FOL, full overlap slotted.* In this design, the outer flaps fully overlap and the inner flaps are of the same length as the outer flaps. If the shape of the container is such that it would result in an overlap of the inner flaps, they will be cut to meet in the center. This design results in a container with least two thicknesses of fiberboard covering the entire top and bottom surfaces.

(6) *OSC, overlap slotted.* In this box, when closed, the inner flaps must not overlap, and the outer flaps will overlap the distance specified in the order or invitation for bids. The inner flaps will be of the same length as the outer flaps, except when the relation of width to length would cause the inner flaps to overlap. In such a case, the inner flaps will be cut to meet in the center of the box.

(7) *OPF, one-piece folder.* When this box is closed, the outer flaps must meet. Unless otherwise specified, the inner flaps will not be less than 2 inches long for folders under 18 inches in width, and not less than 3 inches long for folders 18 inches and over in width. This style is also known as a book wrapper.

(8) *TS, triple-slide.* This design, made from corrugated fiberboard only, is identified by the arrangement of corrugations in which all corrugations run at right angles to the score lines in all parts of the box. It consists of three slides, each of one piece of corrugated fiberboard, scored so as to cover completely four faces of the box. The joint of the inner slide will be left open. The middle slide will be taped at the body joint and will be a sliding fit on the assembled inner and outer slides. The outer slide will be taped at the body joint and will be a sliding fit on the assembled inner and middle slides.

(9) *FPF, five panel folder.* This design consists of a single scored slotted sheet. When set up, the outer end flaps will fully overlap. This box is used to an advantage in the packing of stacked or nested items which can be arranged on the flat scored sheet and when in position, the box is folded over the contents.

h. Sleeves (fig 5-5). A sleeve may be specified for use with any of the box styles to provide added strength. Sleeves will be made from board of the same grade as the box. A sleeve will closely fit the box over which it is placed, and will cover the top, bottom, and both ends. The length of the sleeve (length of the stapled joint) will be the same as the inside width of the box. Unless otherwise specified, the corrugations will be at right angles to the score lines.

i. Liners (fig 5-6). Liners are made of one-piece corrugated, single-wall (SW) or double-wall (DW) fiberboard, and cover the end and side panels of the interior of a fiberboard box. The ends of the liner will meet in the center of one side. When taping is specified, a minimum of 3-inch wide tape, Specification PPP-T-45, will be used to secure the ends of the liner. Flutes of the fabricated liner will be perpendicular to the box opening. Single-wall (SW) board will be of A or C flute; and double-wall board will be of any combination of A, B, or C flutes, except BB.

j. Fabrication of the Boxes.

(1) *Cutting, scoring, and slotting.* Secial machines are used to cut, score, and slot the fiberboard material so that it can be made into a box.

(2) *Body joint (manufacturer's joint) (fig 5-7).*

(*a*) *Domestic boxes, types CF and SF.* The body joint (manufacturer's joint) of domestic corrugated fiberboard boxes will be either lapped, butted, or spliced, as specified. On domestic solid fiberboard boxes only lap joints are permitted, secured by staples or stitching wire.

1. Lapped joint. The lap may be either on the inside or outside of the box and not less than 1¼ inches overlap. It may be secured by staples, stitching wire, glue, or adhesive, depending upon the requirements and type of fiberboard.

2. Butted joint (type CF only). The butted joint will be secured with gummed tape not less than 2 inches wide for gross weights up to 65 pounds, inclusive, and not less than 3 inches wide for gross weights in excess of 65 pounds.

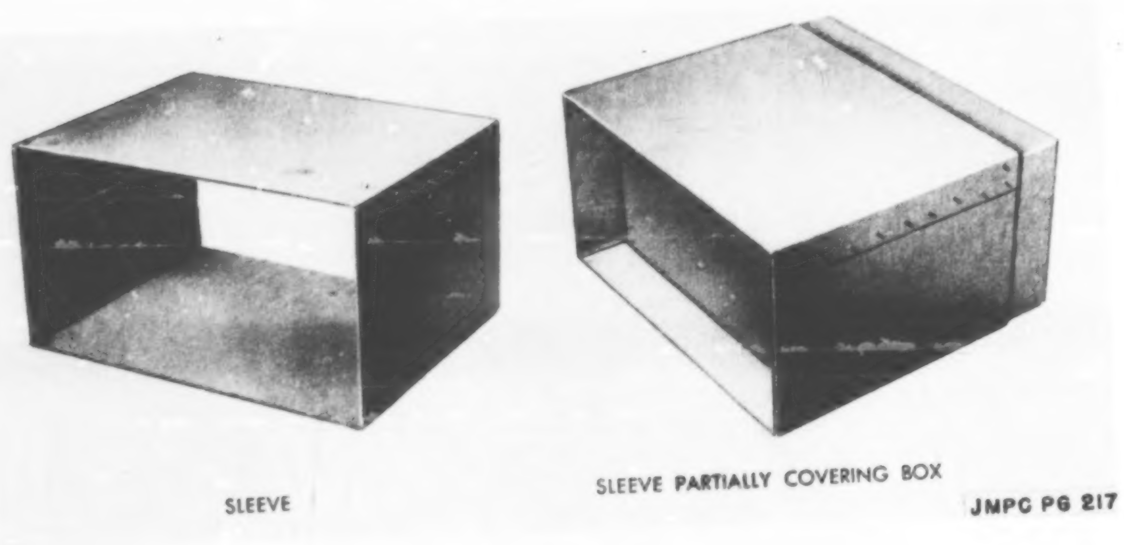
3. Spliced joint. This joint is permitted only on double-wall corrugated fiberboard. The spliced joint is effected by removing the corrugating media and center liner and splicing inner and outer facings over the end of the abutting corrugated fiberboard. The overlap will extend not less than 1 inch. Both facings must be securely glued over the entire area of contact between the facings.

(*b*) *Weather-resistant boxes, type CF and SF.* Only the lap joint may be used on weather-resistant grade boxes (fig 5-7).

1. The lap joint will overlap either inside or outside the box no less than 1½ inch, and will be secured with steel staple or steel stitching-wire. The staples or stitches will be spaced not more than 2 inches apart, and the distance between the outer stitches and the end of the joint will not exceed 1 inch. An additional tie-stitch will be used about ½ inch from the outer stitches at each end of the joint.

2. In lieu of a tie-stitch joint, boxes may be stapled or stitched with the same number of fasteners (including tie-stitches) equally spaced in a single row.

3. When specified, the body joints of grades


SLEEVE

SLEEVE PARTIALLY COVERING BOX

JMPC PG 217

Figure 5-5. Use of a fiberboard sleeve.

W5c and W6c fiberboard boxes may be secured by the use of adhesive conforming to Specification MMM-A-250.

k. Boxmaker's Certificate (fig 5-8).

(1) *Circular certificate.* Each fiberboard box will be plainly marked with the boxmaker's certificate signifying compliance with the requirements of the Uniform or National Motor Freight Classification in effect on the date of invitation for bids. Type CF and type SF, Class domestic boxes are not required to be marked as being in compliance with Specification PPP-636. However, there is no objection to marking boxes that are manufactured in compliance with the specification. Types CF and SF, class weather-resistant boxes and Waterproof and Water Vapor Resistant (WWVR) in addition to the boxmaker's name or certificate, will be marked with the date of manufacture expressed in month and year, such as 1/72; the individual grade or identification symbol, such as V3s; and the specification compliance date including the statement COMPLIES WITH SPECIFICATION PPP-B-636 and also the minimum average bursting strength. The required data will occupy a total area of not more than 36 square inches. The circular certificate does not have to show the bursting strength of the board as required by Specification PPP-B-636. There is no objection, however, to a statement beneath the boxmaker's certificate to guarantee the box as having the dry bursting strength required by the Specification.

(2) *Rectangular certificate.* When fiberboard boxes fabricated in conformance with Specification PPP-B-636, and authorized by package number in the Uniform Freight Classification requirements but not Rule 41, the rectangular package number form of certificate must be used instead of the circular form. The rectangular form of certificate must be used on fiberboard boxes authorized for shipment of explosives and other dangerous materials.

l. Method of Closure.

(1) *Class domestic boxes.* Unless otherwise specified, all styles of domestic boxes will be closed in conformance with common carrier requirements. Such requirements are found in Rule 41 of the Uniform Freight Classification or the Consolidated Freight Classification.

(2) *Class weather-resistant boxes (styles RSC, OSC, FOL, SFF, and CSSC).* All slotted styles (fig 5-9) of exterior and interior fiberboard boxes will be closed by one of the three following methods:

(a) *Use of adhesives.* MMM-A-250 adhesive is applied to both bottom and top flaps over the entire area of contact between the inner and outer flaps, as illustrated in figure 5-9. Weights are usually necessary to keep the flaps down until the adhesive dries.

(b) *Combination of stitches and adhesive.* The bottom set of flaps is stitched prior to packing. The number of stitches to be used is based upon the inside width of the box in inches. When stitching the bottom flaps, half of the stitches or staples will pass through each of the inner flaps and be distributed in such a manner as to fasten all flaps together over the entire area of contact between inner and outer flaps. This is to prevent the lifting of free edges and corners (fig 5-9). After packing, the other set of flaps (top of the box) is sealed with MMM-A-250 adhesive in the same manner described for this method above.

(c) *Taping (styles RSC and CSSC).* These styles, which are to be overpacked for shipment, may, when

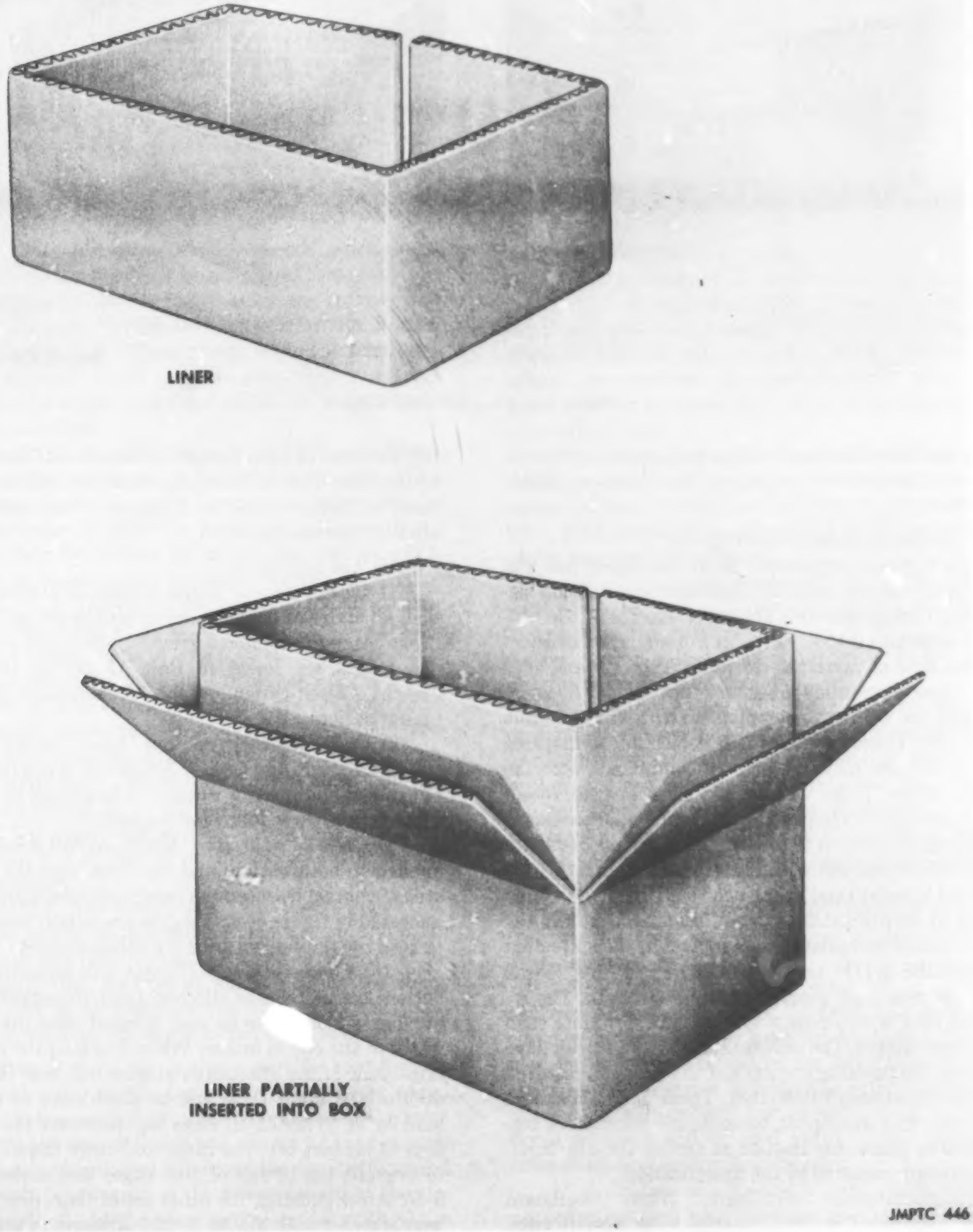
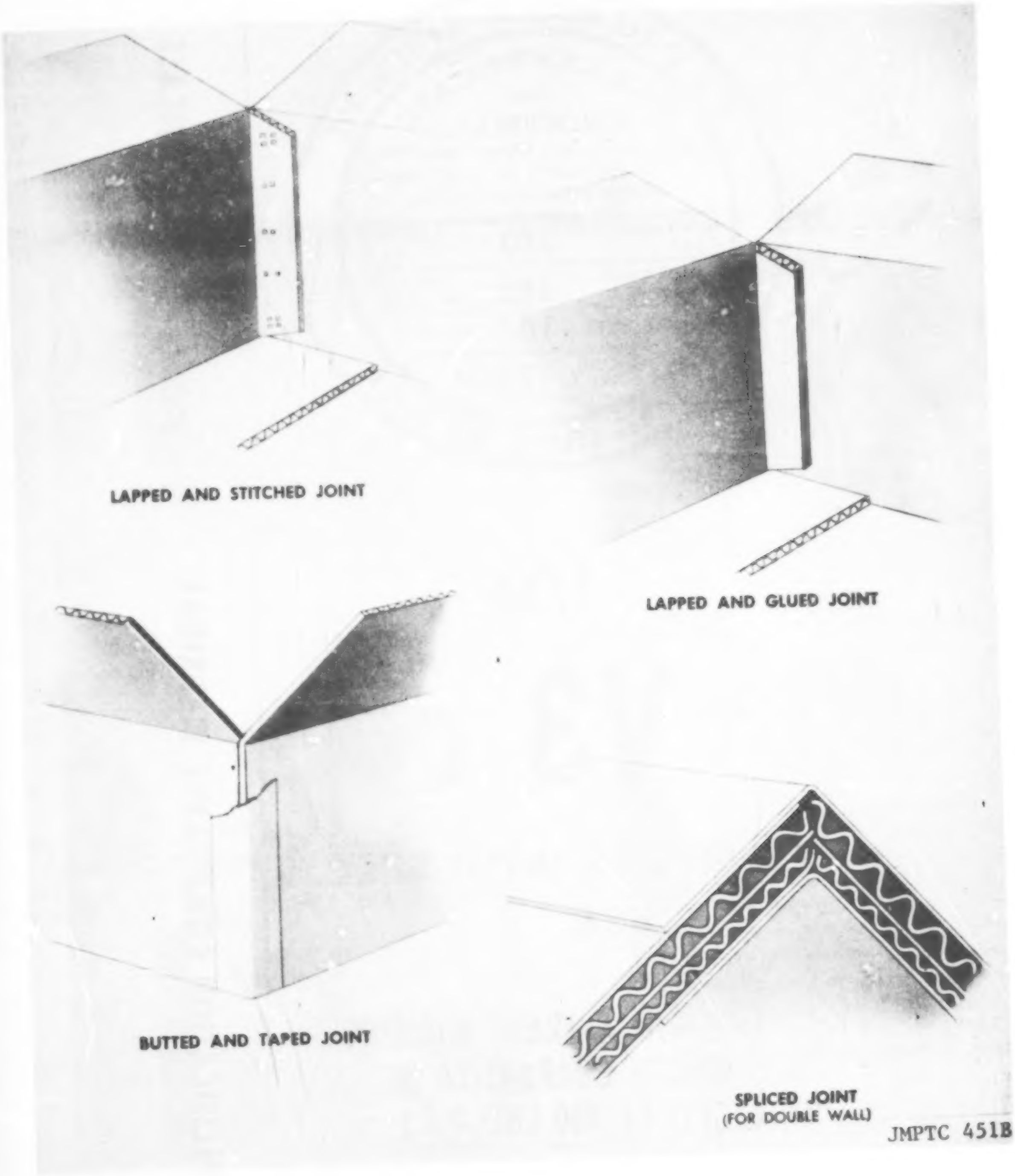

LINER
LINER PARTIALLY INSERTED INTO BOX
JMPTC 446

Figure 5-6. Use of a fiberboard liner.



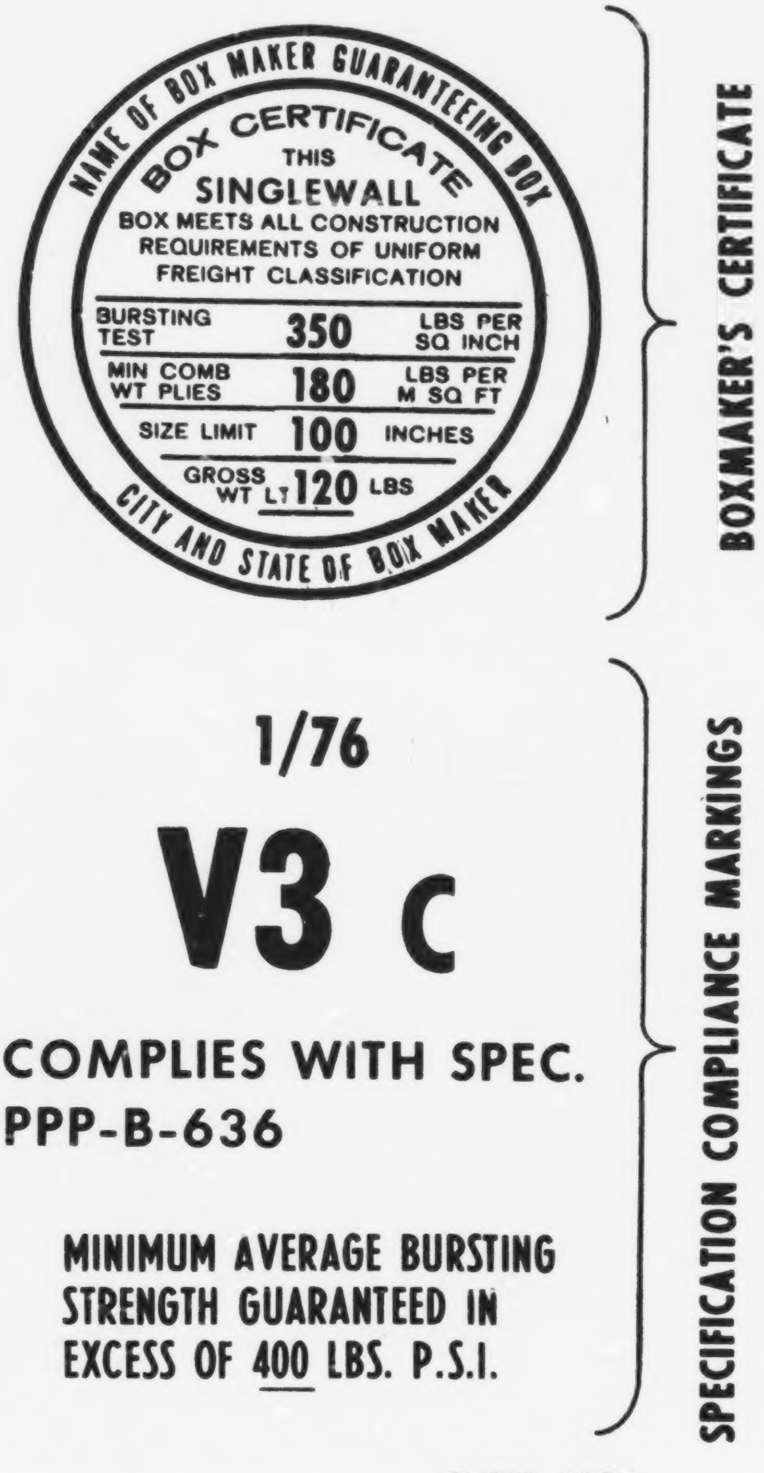
LAPPED AND STITCHED JOINT

LAPPED AND GLUED JOINT

BUTTED AND TAPED JOINT

SPLICED JOINT
(FOR DOUBLE WALL)

Figure 5-7. Body joints for fiberboard boxes.



NAME OF BOX MAKER GUARANTEEING BOX

BOX CERTIFICATE

THIS
SINGLEWALL
BOX MEETS ALL CONSTRUCTION
REQUIREMENTS OF UNIFORM
FREIGHT CLASSIFICATION

BURSTING TEST	350	LBS PER SQ INCH
MIN COMB WT PLIES	180	LBS PER M SQ FT
SIZE LIMIT	100	INCHES
GROSS WT LT	120	LBS

CITY AND STATE OF BOX MAKER

1/76

V3 c

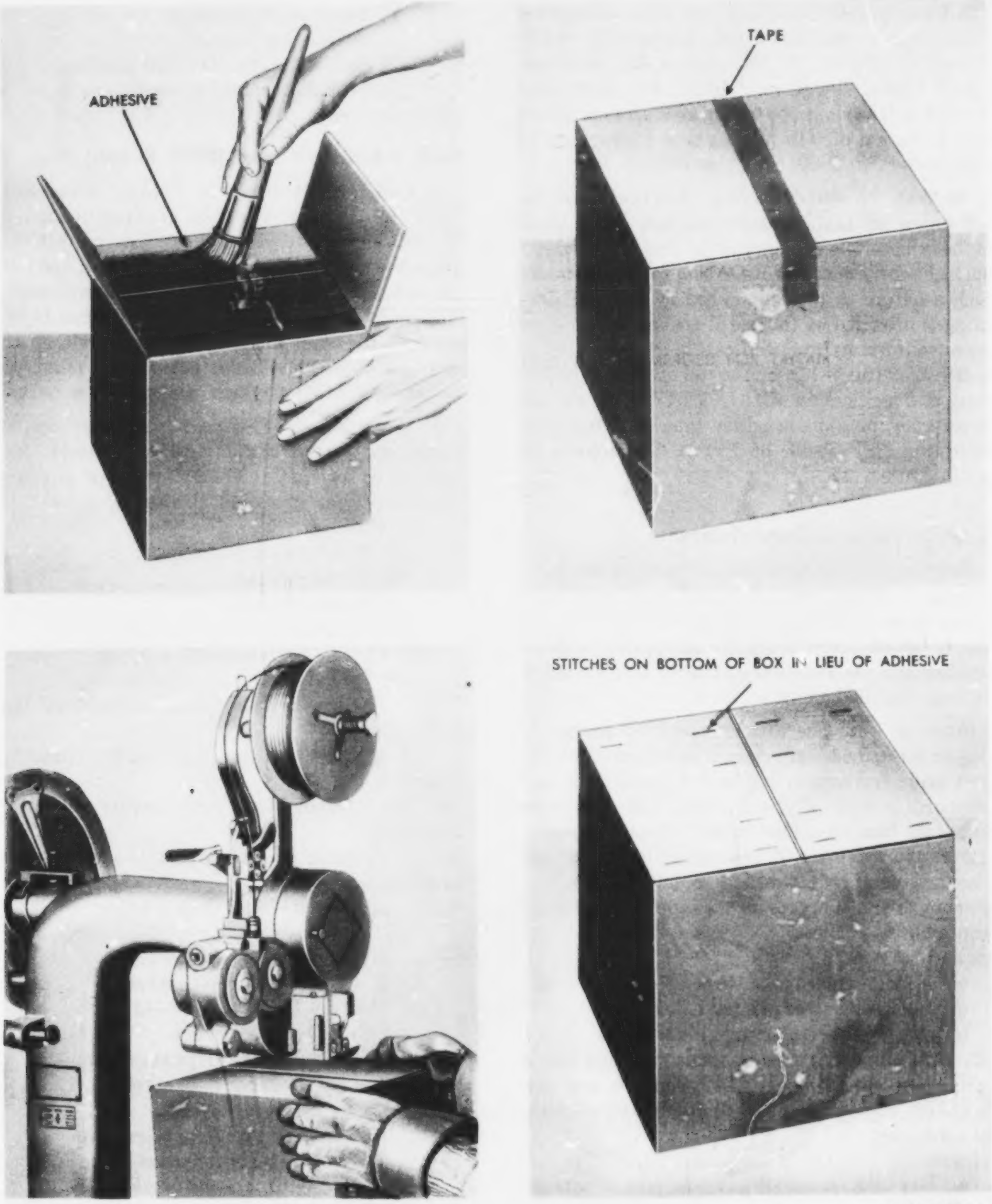
COMPLIES WITH SPEC.
PPP-B-636

MINIMUM AVERAGE BURSTING
STRENGTH GUARANTEED IN
EXCESS OF 400 LBS. P.S.I.

BOXMAKER'S CERTIFICATE
SPECIFICATION COMPLIANCE MARKINGS

JMPTC 218K

Figure 5-8. Sample (circular) boxmaker's certificate and compliance statement.


ADHESIVE
TAPE
STITCHES ON BOTTOM OF BOX IN LIEU OF ADHESIVE

JMPTC 219 B

Figure 5-9. Closure of fiberboard boxes with adhesives, tape, or stitches.

best copy available

specified, have the top and bottom flaps closed with 2-inch wide tape conforming to Specification PPP-T-76.

(3) *Class weather resistant and class waterproof and watervapor resistant boxes (styles FTC, OPF, FPF, and TS) (fig 5-10).* All exterior full telescope, one-piece folder, five-panel folder, and triple slide style boxes will be closed by taping all seams and joints with a minimum of 3-inch wide tape conforming to Specification PPP-T-60, class 1, or PPP-T-76.

m. Methods of Waterproofing. Although both V- and W-board are highly water-resistant, boxes made from these materials will permit the entrance of water through the corners and joints. When packed items are of such a nature as to be damaged by water, waterproofing is provided by the use of individual wraps of material conforming to Specification PPP-B-1055 or MIL-B-13239 (fig 5-11); by the use of caseliners conforming to Specification MIL-L-10547; or by the use of waterproof, pressure-sensitive tape conforming to Specification PPP-T-60, or PPP-T-76, applied as shown in figure 5-12.

5-3. Paperboard Containers

a. Description. Paperboard containers, in the form of folding or set-up boxes, are fabricated with automatic machines and delivered to the user in a flat, collapsed, or set-up form, ready for mechanical or hand assembling and use. Procurement of the boxes must be made from qualified manufacturers.

b. Intended Use. The articles normally packed in folding or set-up boxes are classed as supporting loads (Type 1 load), semisupporting loads (Type 2 load), and nonsupporting loads (Type 3 load). The maximum weight of the load should not exceed 10 pounds.

(1) *Supporting load.* A supporting load is a rigid and rectangular product which completely fills and fully contacts and supports all the interior surfaces of the container.

ExamplesL

(*a*) A rectangular bar of soap.
(*b*) Books and other printed matter.
(*c*) One or more rectangular inner packs.

(2) *Semisupporting load.* A semisupporting load is a rigid or semirigid product which contacts and supports at least some portions of all the interior surfaces of the container.

Examples:

(*a*) One or more cylindrical cans, jars, or bottles.
(*b*) Automotive or airplane parts.
(*c*) Small arms ammunition.

(3) *Nonsupporting load.* A nonsupporting load is a flexible, powdered, flaked, crystalline, or odd-shaped product which either results in a concentrated load or does not contact and support all the interior surfaces of the container.

Examples:

(*a*) Flour, sugar, soap powders, etc.
(*b*) Odd-shaped parts.
(*c*) Semisolids such as butter and lard.
(*d*) Soft line clothing items, such as socks, underwear, etc.

5-4. Folding Boxes (PPP-B-566)

a. General Requirements. Folding boxes will conform to the requirements of Specification PPP-B-566. These boxes are made of good quality bending paperboard of a thickness between 0.012 and 0.045 of an inch. The paperboard, when scored, will withstand folding to 180 degrees without visible cracks or fractures on the outer surface. When greater than normal strength is required, the paperboard must possess specified bursting strength values.

b. Classification. There are many varieties, styles, types, and classes of folding boxes suitable for unit packing or segregation of small items of supplies. The varieties, styles, types, and classes are—

(1) *Varieties:*
  (*a*) Nonresistant paperboard.
  (*b*) Water resistant.
  (*c*) Grease resistant.
  (*d*) Water and grease resistant.
(2) *Style I—Seal end (fig 5-13).*
  (*a*) *Type A—Outer flaps full overlap.*
    1. Class a—Inner flaps at random, but not overlapping.
    2. Class b—Inner flaps meeting minus $\frac{1}{16}$ inch tolerance.
  (*b*) *Type B—Outer flaps meting minus $\frac{1}{16}$ inch tolerance.*
    1. Class a—Inner flaps at random but not overlapping.
    2. Class b—Inner flaps meeting.
  (*c*) *Type C—Self-sealing.*
    1. Class c—Single sealed ends.
    2. Class d—Double sealed ends.
(3) *Style II—Tuck end (fig 5-13).*
  (*a*) *Type D—Reserve tuck.*
    1. Class a—Inner flaps at random.
    2. Class e—Inner flaps specified.
  (*b*) *Type E—Straight tuck.*
    1. Class a—Inner flaps at random.
    2. Class e—Inner flaps specified.
(4) *Style III—Brightwood blank (fig 5-13).*
  (*a*) *Type F—One piece with cover attached.*
    1. Class f—No dust flaps.
    2. Class g—Dust flaps on side panel.
    3. Class h—Dust flaps on cover.
  (*b*) *Type G—Two-piece.*

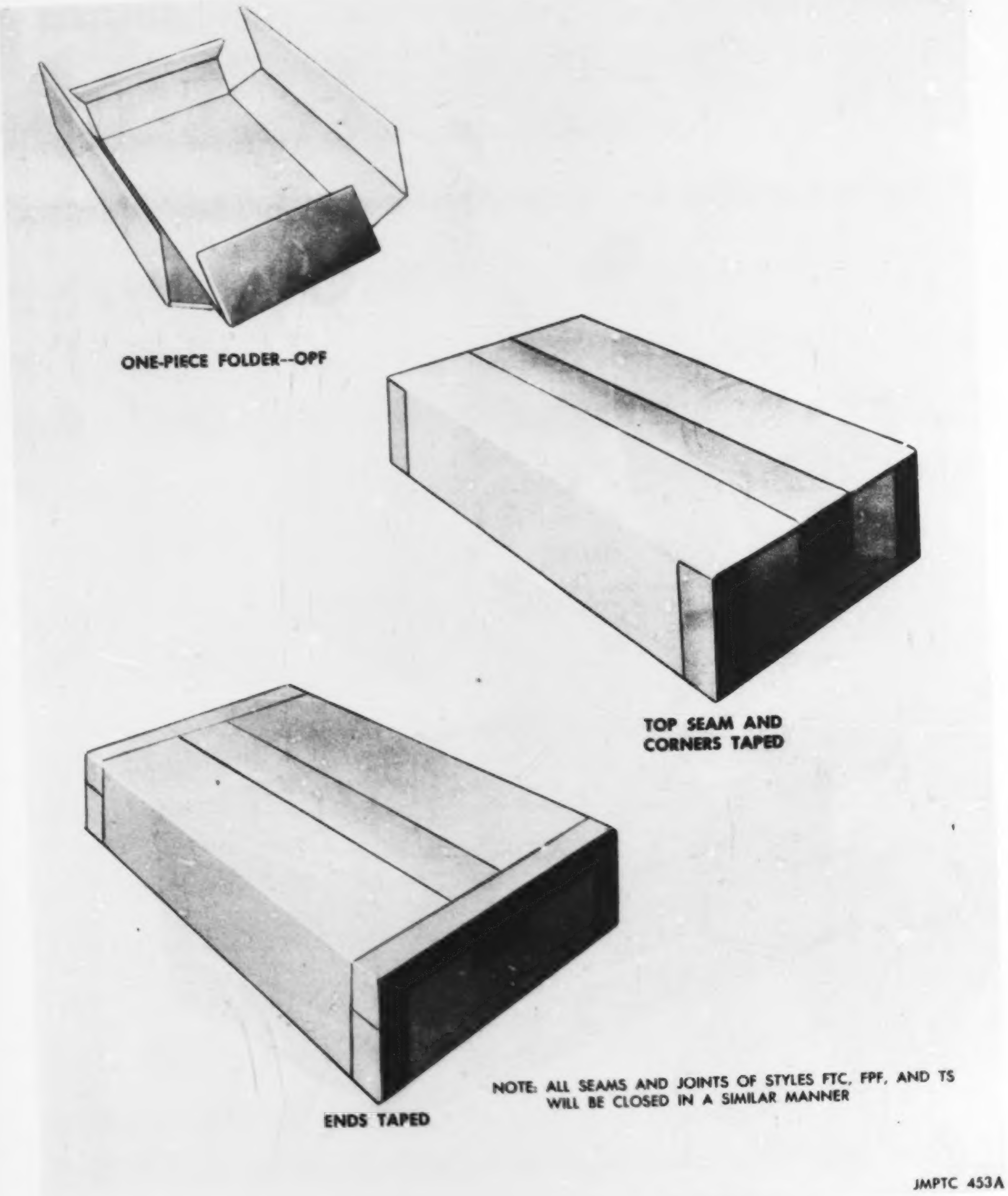

ONE-PIECE FOLDER--OPF
TOP SEAM AND CORNERS TAPED
ENDS TAPED
NOTE: ALL SEAMS AND JOINTS OF STYLES FTC, FPF, AND TS WILL BE CLOSED IN A SIMILAR MANNER
JMPTC 453A

Figure 5-10. Closure of nonslotted class weather-resistant fiberboard boxes with tape.

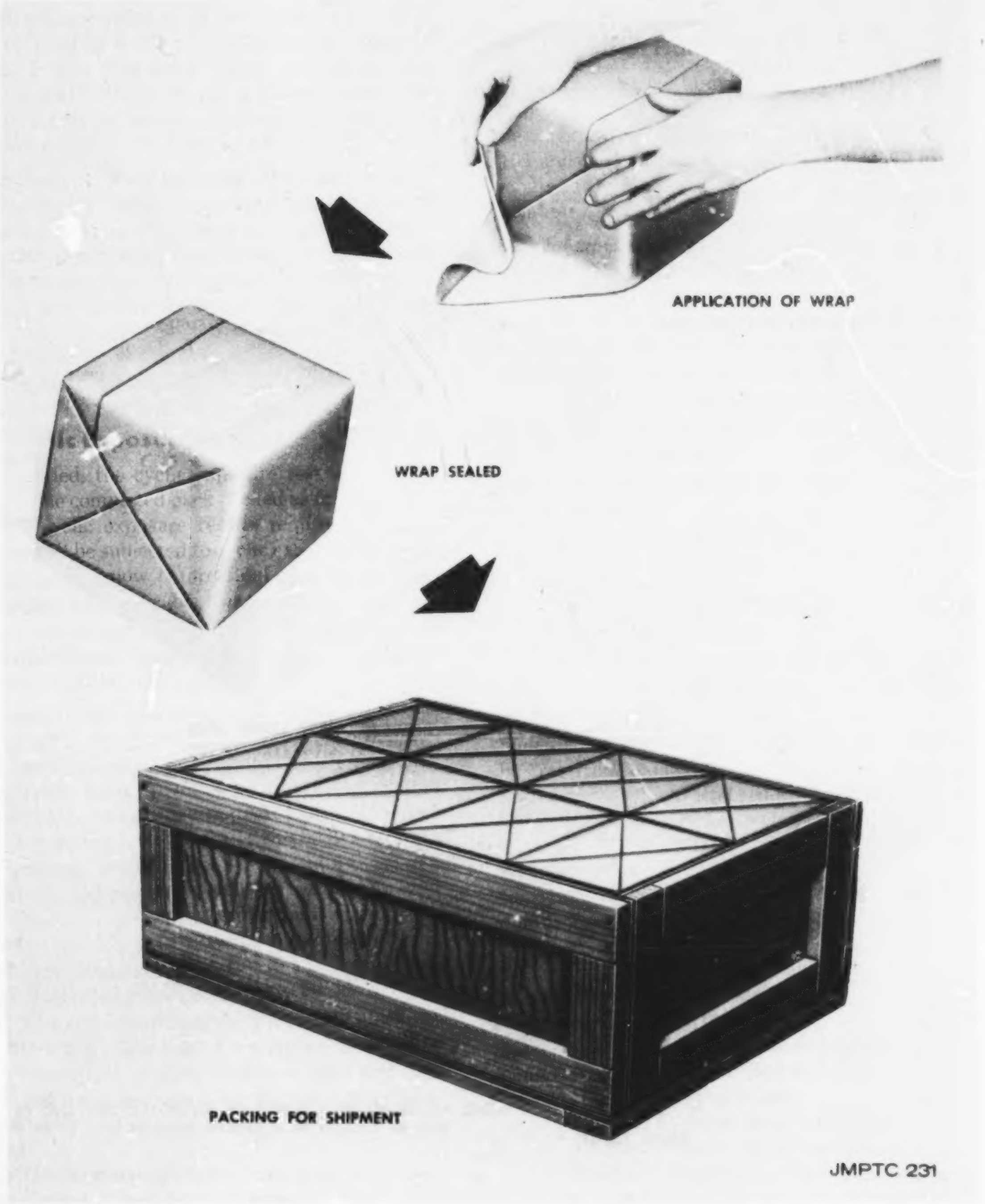

APPLICATION OF WRAP
WRAP SEALED
PACKING FOR SHIPMENT
JMPTC 231

Figure 5-11. Waterproofing of individual packages.

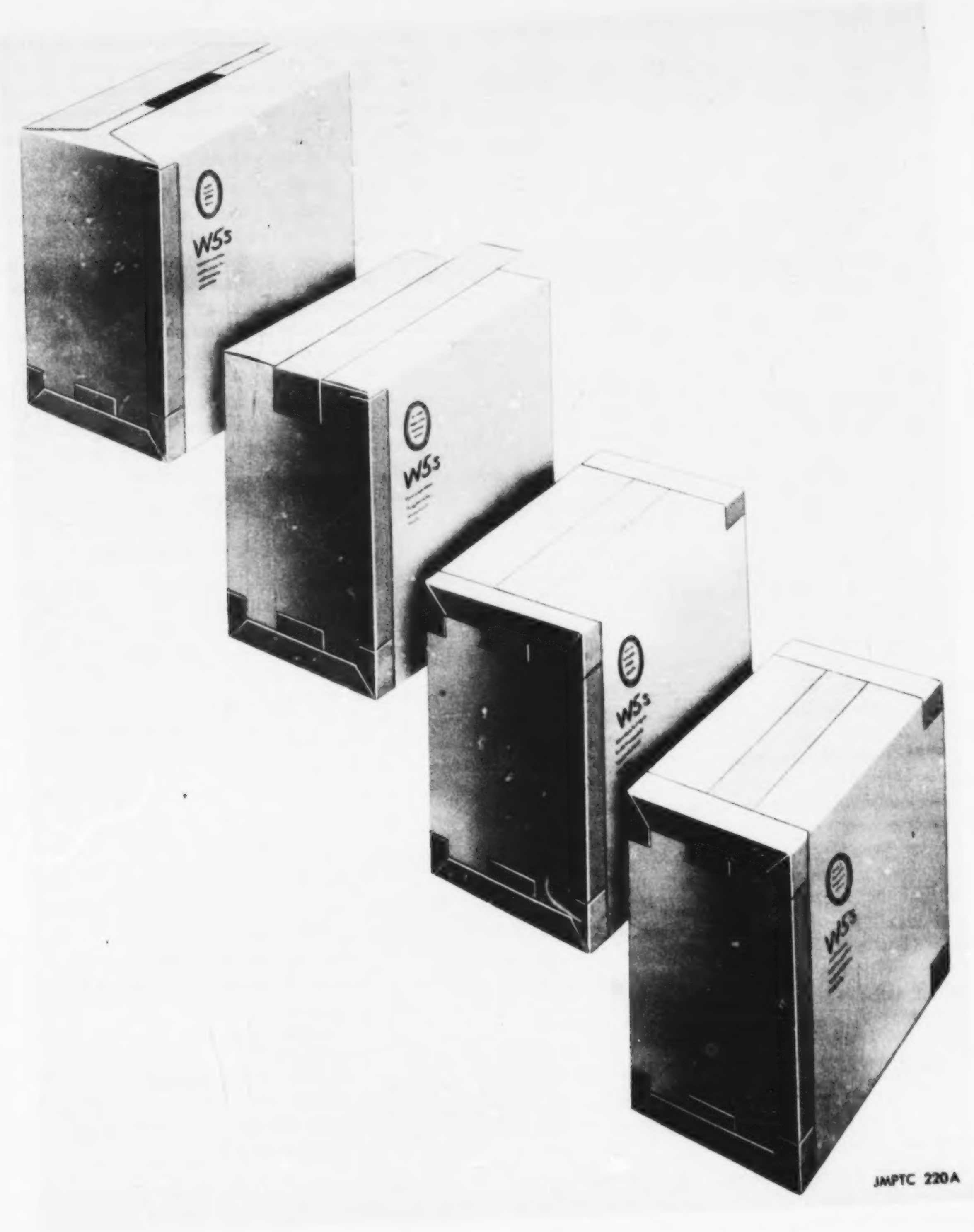

W5s
W5s
W5s
W5s
JMPTC 220A

Figure 5-12. Waterproofing of fiberboard boxes with tape.

1. Class i—Full telescope.
2. Class j—Partial telescope.

(a) Subclass 1—No turnover on sides or ends.

(b) Subclass 2—With or without turnover on sides or ends. Depth of lid specified.

(c) *Type H—One-piece tray.*

(5) *Style IV—Overlapping end wall (with or without double side walls) (fig 5-13).*

(a) *Type I—Two-piece hardware lock.*
1. Class i—Full telescope.
2. Class j—Partial telescope.
3. Class k—One piece tray.

(b) *Type J—Two-piece friction end.*
1. Class i—Full telescope.
2. Class j—Partial telescope.
3. Class k—One-piece tray.

(6) *Style V—Cracker style lock end (fig 5-14).*
(7) *Style VI—Tube and slide (fig 5-14).*
(8) *Style VII—One-piece folders (fig 5-14).*
(9) *Style VIII—Diagonal folds (fig 5-14).*

(a) *Type F—One-piece, cover attached.*
1. Class f—No dust flaps.
2. Class g—Dust flaps on side panel.
3. Class h—Dust flaps on cover.

(b) *Type G—Two-piece.*
1. Class i—Full telescope.
2. Class j—Partial telescope.

(c) *Type H—One-piece tray.*

(10) *Style IX—Double lock-end top and bottom (fig 5-15).*

(11) *Style X—Snap lock bottom with tuck top (fig 5-15).*

(12) *Style XI—Automatic fold, bottom and side glued (fig 5-15).*

(13) *Style XII—Center support for rolls of tape (fig 5-15).*

(a) *Type K—One-piece sleeve.*

1. Class l—For widths of rolls up to, and including, 1 inch.
2. Class m—For widths of rolls up to, and including, 3 inches.
3. Class n—For widths of rolls up to, and including, 4 inches.

(14) *Style XIII—Hinged, full depth cover with window.*

(15) *Style XIV—Double lock-end top and bottom.*

c. Weatherproofing. As these boxes are not weatherproof, they must be satisfactorily protected by suitable means for oversea shipments.

d. Closure. Unless otherwise specified, the type of closure will be indicated by the style of the box. Locks provided for box closures will be carefully and securely assembled. When specified, telescopic styles will be closed by means of tape meeting the requirements of Federal Specifications PPP-T-45 or PPP-T-76. The tape is used to seal and strengthen the box. The amount of tape used and its application is dependent upon the nature of the contents. Under some conditions, it will be sufficient to apply a small piece of tape to overlap the closure by 1 inch. In other instances, where the contents are heavy, it may be necessary to run the tape entirely around the container.

e. Use. Only those articles which are not easily susceptible to damage which might be caused by ordinary distortion of the box, resulting from external forces during shipment, should be packed in folding paperboard boxes. These boxes are generally used for unit and intermediate packing. Normally, the weight of contents for these boxes is limited to 10 pounds, however, when in the judgment of the supervisor or other authority they are adequate for heavier loads, they may be so used. The resistant variety boxes are intended for use in packing items coated with oil or grease, for retaining the moisture content of the item packed, or for both, as applicable. Resistant variety boxes are not intended to be weatherproof (*c* above).

5-5. Set-Up Boxes (PPP-B-676)

a. Description and Classification. This paragraph deals with new set-up boxes manufactured from nonbending paperboard. These boxes come in the following types, varieties, classes, and styles:

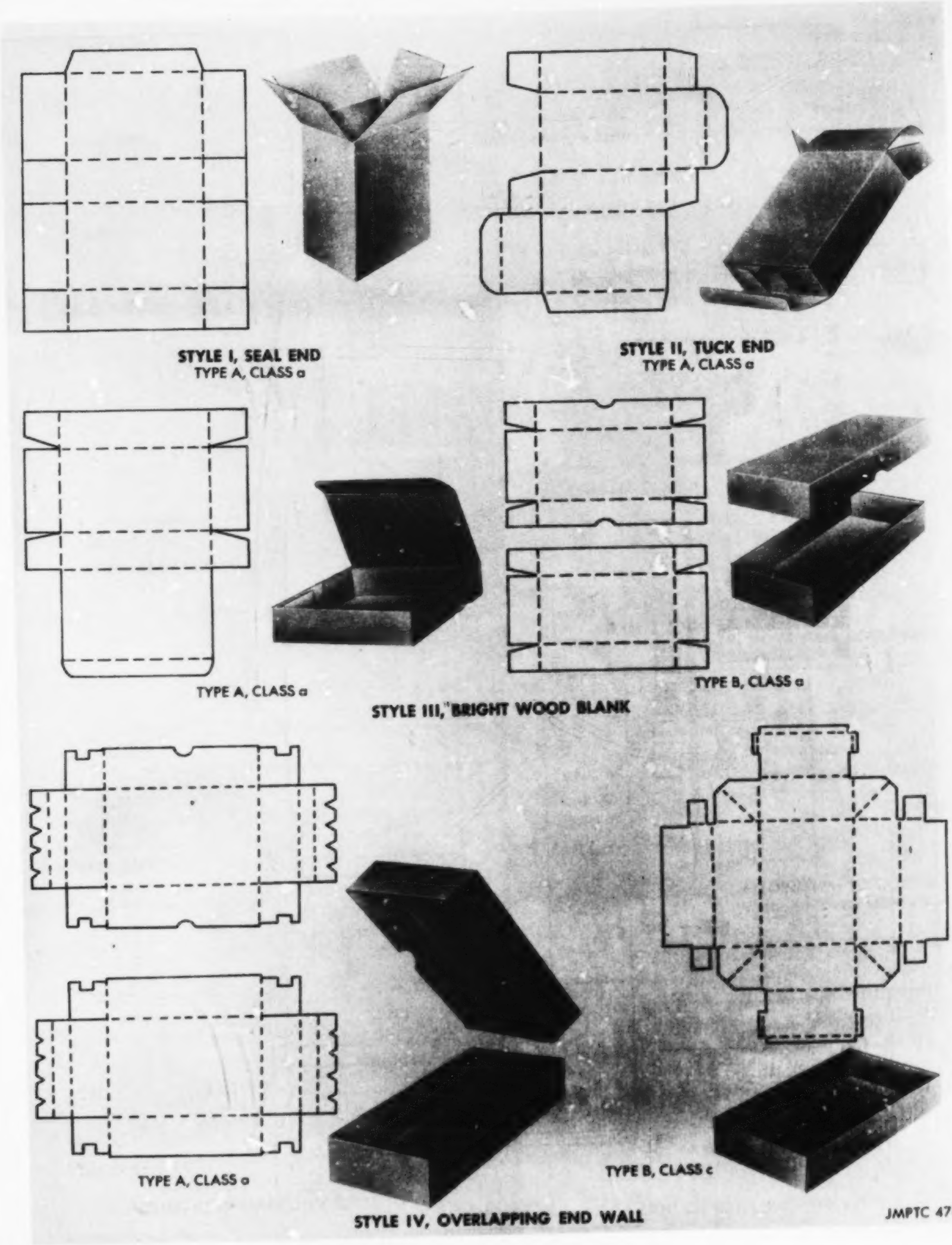
(1) *Types (fig 5-16).*
(*a*) I—Full telescope.
(*b*) II—Partial telescope or shallow lid.
(*c*) III—Neck or shoulder.
(*d*) IV—Slide boxes.

(2) *Varieties.*
(*a*) 1—Plain.
(*b*) 2—Water resistant.
(*c*) 3—Grease resistant.
(*d*) 4—Water and grease resistant.

(3) *Classes.*
(*a*) A—Blank, corner stayed.
(*b*) B—Blank, corners stitched or glued.
(*c*) C—Blank, corners cut without stays.
(*d*) D—Blank, end set.
(*e*) E—Blank, bottom set.

(4) *Styles (fig 5-17).*
(*a*) 1—Banded or strip stayed.
(*b*) 2—Trimmed.
(*c*) 3—Strip-covered.
(*d*) 4—Tight-wrapped.

b. Intended Uses. Set-up boxes are generally used for interior packing, to give added protection to the packed articles and for convenience in handling. Only those articles which are not easily susceptible to damage that might result from ordinary distortion of the



STYLE I, SEAL END
TYPE A, CLASS a

STYLE II, TUCK END
TYPE A, CLASS a

TYPE A, CLASS a

TYPE B, CLASS a

STYLE III, "BRIGHT WOOD BLANK

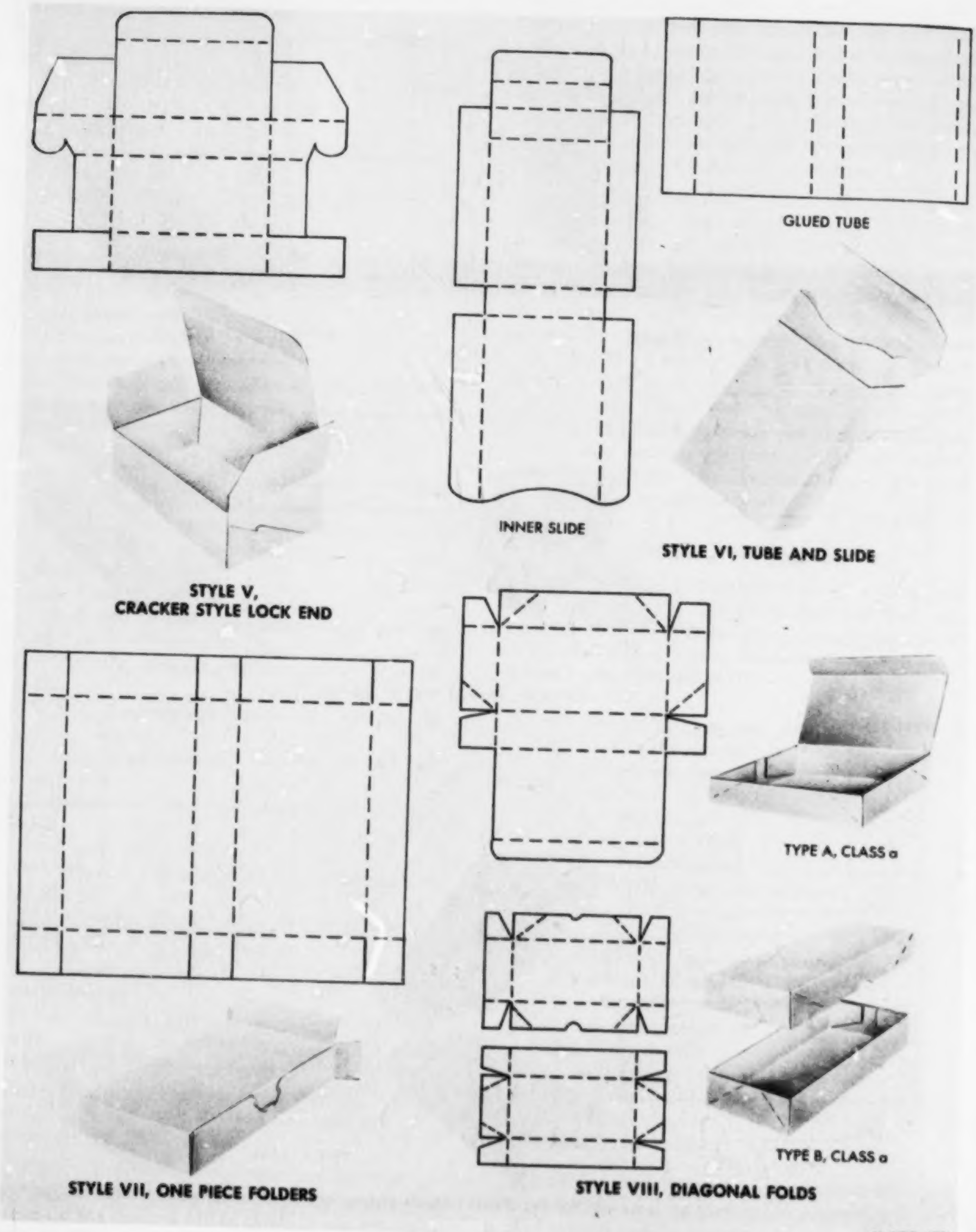
TYPE A, CLASS a

TYPE B, CLASS c

STYLE IV, OVERLAPPING END WALL

JMPTC 476A

Figure 5-13. Style I, II, III, and IV, paperboard, folding boxes.



GLUED TUBE

INNER SLIDE

STYLE VI, TUBE AND SLIDE

STYLE V,
CRACKER STYLE LOCK END

TYPE A, CLASS a

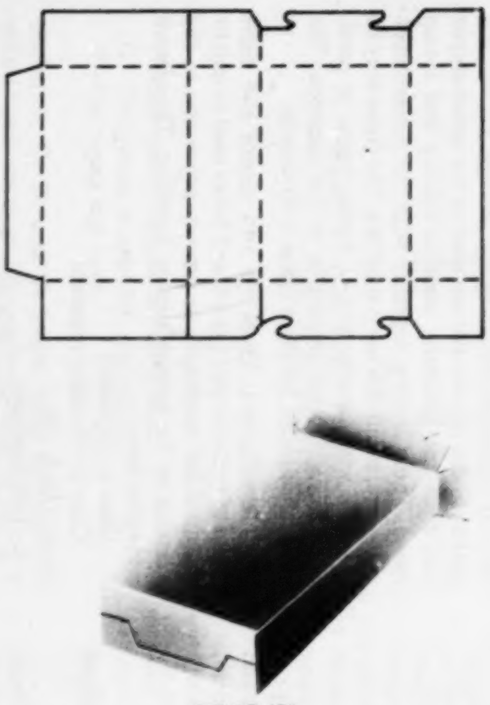
TYPE B, CLASS a

STYLE VII, ONE PIECE FOLDERS

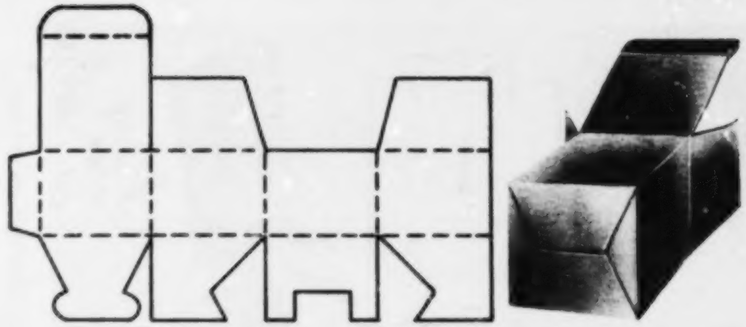
STYLE VIII, DIAGONAL FOLDS

JMPTC 477A

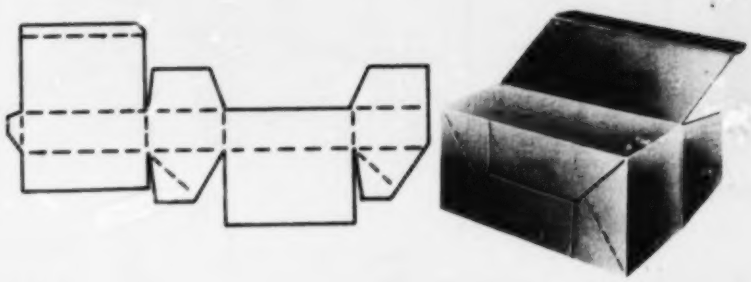
Figure 5-14. Styles V, VI, VII, and VIII, paperboard, folding boxes.



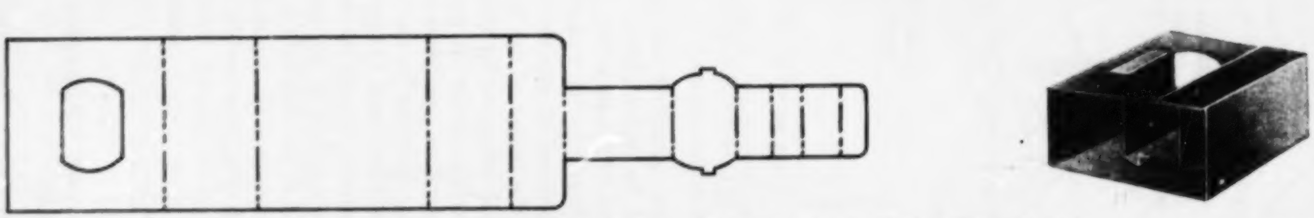
STYLE IX,
DOUBLE LOCK END TOP AND BOTTOM



STYLE X, SNAP LOCK BOTTOM WITH TUCK TOP



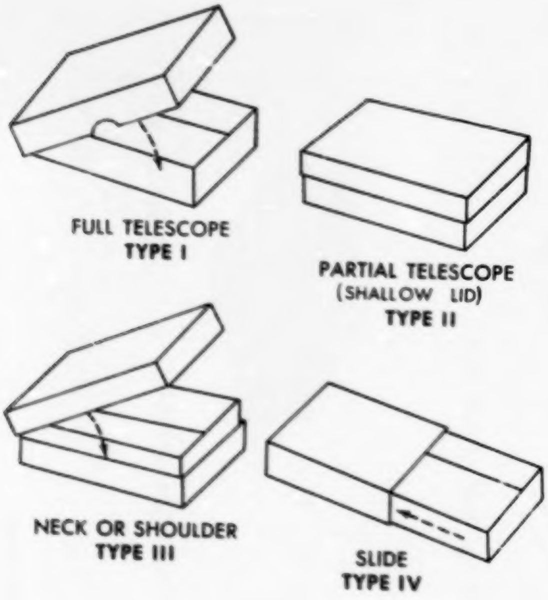
STYLE XI, AUTOMATIC FOLD



STYLE XII, TYPE A, CLASS C, CENTER SUPPORT FOR ROLLS

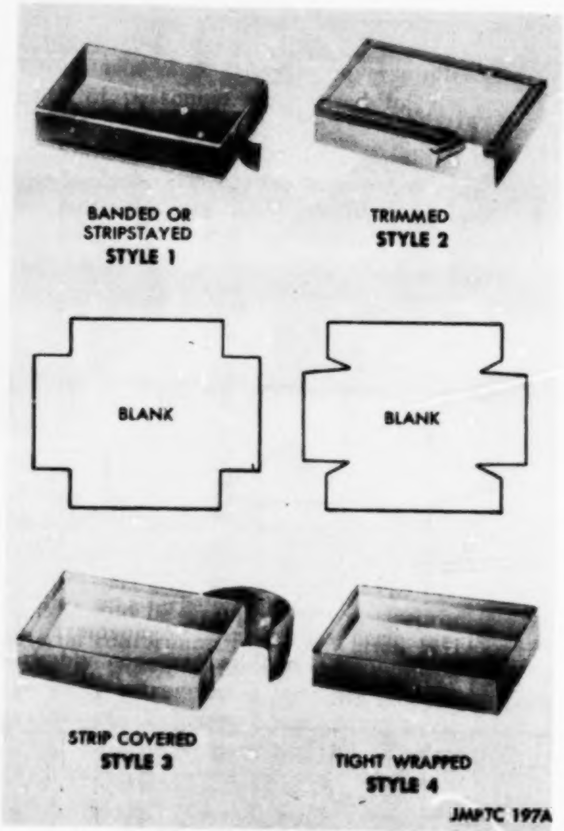
JMPTC 478 B

Figure 5-15. Styles IX, X, XI, and XII, paperboard, folding boxes.



JMPTC 196A

Figure 5-16. Types of paperboard, set-up boxes.



JMPTC 197A

Figure 5-17. Styles of paperboard, set-up boxes.

set-up box, caused by external forces during shipment, should be packaged in these boxes.

c. *Closure.* Unless otherwise specified, closure of set-up boxes will be accomplished by means of gummed paper tape of 2-inch width. Applications of the tape will be indicated by the type of box. Telescope type boxes will be closed by applying a strip of tape girthwise around the center of the box and overlapping not less than 2 inches, or by applying a strip of tape that will securely cover the full perimeter seam of the box. Neck or shoulder type boxes will be closed in the same manner as specified for the telescope types. Slide type boxes will be closed by applying a strip of tape centered lengthwise around the box and overlapping not less than 2 inches, or by applying strips of tape over each end of the base (tray), and extending not less than 2 inches over the top and bottom of the slide (shell) on each end. Tape used for varieties 1 and 3 boxes will conform to Type III, Grade B of Federal Specification PPP-T-45 and for varieties 2 and 4 will be in accordance with Federal Specification PPP-T-76.

5-6. Metal-Stayed Paperboard Boxes (PPP-B-665)

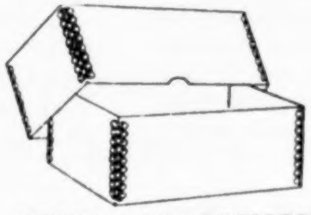
a. *Description and Uses.* Metal-stayed paperboard boxes consists of one or more paperboard flats assembled with metal stays. A great number of military depots are equipped with a machine known as The Metal Edge Box Stayer. The machine joins and reinforces box corners with a metal edging or stay. The metal-stayed paperboard box may be used as a unit of intermediate container to provide protection to the contents or to facilitate handling and storage. Thicker and better grades of material are used in the metal-stayed box than are generally used in folding and set-up boxes. These factors, together with the metal-stayed stiffeners, result in a more rigid box. The boxes may be specified with interior blocks, forms, trays, or partitions for additional protection to the contents. The weight limitation for these boxes is 40 pounds.

b. *Classification.* There are two classes and eight styles of metal stayed paperboard boxes used as unit or intermediate containers to provide protection to the contents or for convenience in handling. The classes and styles are—

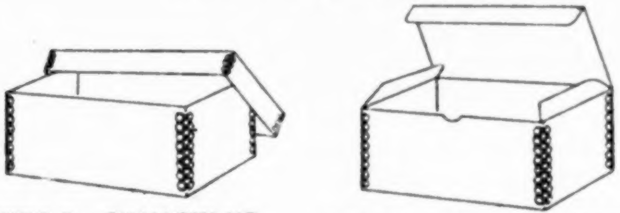
Class 1—Domestic
Class 2—Weather-resistant

Styles: (fig 5-18)

A—Full telescope.
B—Partial telescope or shallow lid.
C—One piece, hinged lid.
D—One piece, hinged lid, telescope.
E—Neck or shoulder.

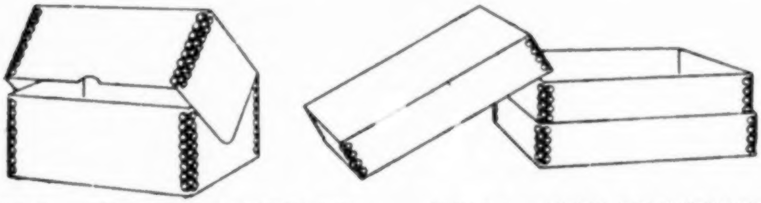


STYLE A - FULL TELESCOPE



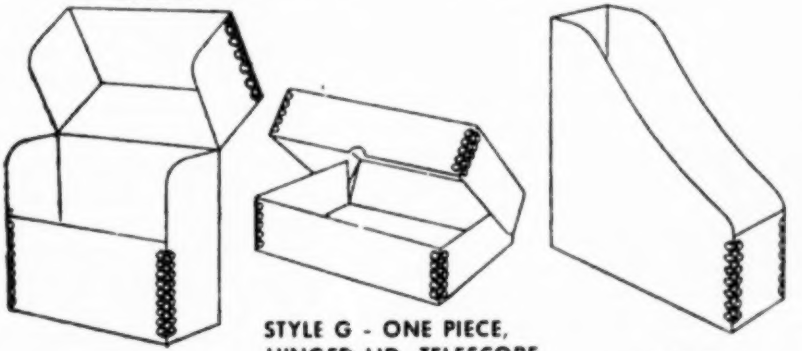
STYLE B - SHALLOW LID

STYLE C - ONE PIECE, HINGED LID



STYLE D - ONE PIECE, HINGED LID TELESCOPE

STYLE E - NECK OR SHOULDER



STYLE F - ONE PIECE, HINGED LID, DROP FRONT

STYLE G - ONE PIECE, HINGED LID, TELESCOPE, BOOK STYLE

STYLE H - CUT-AWAY TOP CASE

JMPTC 378A

Figure 5-18. Styles of metal-stayed, paperboard boxes.

F—One piece, hinged lid, drop front.
G—One piece, hinged lid, telescope.
H—Cut-away top case.

Styles A, C, D, and G boxes shall be provided with thumb notches. The neck or collar of Style E boxes shall be made from the same board as the base, shall extend to the bottom surfaces of the box and shall be provided with metal stays at the four corners. The base and lid of Style E boxes shall be of equal depth and the sum of their depths shall equal the depth of the neck or collar, or the inside depth of the box. When specified, Style F boxes shall be provided with a pull hole or a pull string. Each box shall consist of one or more paperboard blanks or flat assembled with metal stays to comply to one of the box styles illustrated in figure 5-18. The paperboard shall consist primarily of unbleached kraft fiber and shall be of the thickness specified.

c. Closure. Metal-stayed paperboard boxes are closed by means of gummed tape, as required. Closure of the Class 1 boxes may be made with 1- or 2-inch wide tape conforming to PPP-T-45. Closure of the Class 2 boxes may be made with 1- or 2-inch wide tape conforming to PPP-T-76.

5-7. Triple-Wall Corrugated Fiberboard (PPP-B-640)

a. General. These boxes are made from triple-wall corrugated fiberboard (fig 5-1) which makes them exceptionally good as packing containers. They are used occasionally as unit pack containers, such as for storage batteries.

b. Additional Information. For additional information on these containers, refer to TM 38-230-2.

CHAPTER 6

CANS AND DRUMS

6-1. Description, Classification and Selection Factors

a. Description.

(1) *Cans.* Cans are lightweight containers made of metal, paperboard, pulpboard, or a combination of metal and paperboard or pulpboard. Cans may be round, square, oval, oblong, or rectangular in shape. They have a variety of closures and may be used for vacuum or pressurized packaging. Most cans are used for interior packaging.

(2) *Drums.* Drums are cylindrical, straight-walled containers made of metal, plastic, fiber or plywood, or a combination of metal and fiber, wood or plywood. Drums may be provided with rolling hoops. Rolling hoops may be pressed or expanded from the body of the drum, or may be I-bars welded to the body. Drums may have tight or removable heads.

b. Classification. Cans and drums are broadly classified as to use, that is interior or exterior containers, and reusable and nonreusable containers. They are also classified as to composition—metal and nonmetal.

(1) *Interior and exterior containers.*

(*a*) *Interior.* Interior cans are usually 1 gallon or less in capacity, constructed of lightweight material, and are used for small items. These containers may be utilized for unit packing as specified in Specification MIL-P-116. Interior type containers are packed in exterior containers such as fiberboard boxes, cleated panel boxes, wirebound wood boxes, or nailed wood boxes for shipment.

(*b*) *Exterior.* These containers consist of cans of larger capacity, pails, reusable type metal containers, and drums. Exterior containers are designed to withstand rougher usage. They may be palletized for convenience in handling.

(2) *Reusable and nonreusable containers.*

(*a*) *Reusable.* Certain cans, metal containers, and drums are designed for reuse. The reusable type is very convenient for the return shipment of repairable items. This feature is particularly advantageous in cases where repairable instruments or accessories can be packed for shipment to the maintenance overhaul activity in the container in which the replacement item was received. Multiple trip drums may, under certain conditions, be refilled and reused for the shipment of liquid, powdered or granular commodities.

(*b*) *Nonreusable.* Single trip containers are usually discarded after their first use. One type, the strippable drum, is filled with a hot liquid which solidifies after cooling. At destination, the drum is torn away from the inclosed product. Other single trip containers, designed of light gauge material, are discarded after the first trip because of requirements of the Hazardous Materials Regulations Department of Transportation or because the general physical condition of the container would not warrant another trip.

(3) *Metal and nonmetal.* Cans and drums are usually made from metal, although cans may be made from fiberboard or paperboard and drums may be made from fiber. The most common metal used in cans is steel, covered with a thin coating of tin or ternepiate (lead-tin alloy coating). The most common metal used for drums is mild steel. Some drums, however, are made of aluminum, nickel, stainless steel, or Monel. Interior and exterior drums are also made of various plastic compositions.

c. Use and Selection Factors.

(1) *Use.* A wide range of items and commodities are adaptable for shipping in cans and drums. Liquids, semiliquids, semisolids, granular, flakes, and powdered materials, and solids may be shipped in specified types of these containers. Fragile items and precision instruments may be given the high degree of protection they require by the use of cans or drums. Hazardous materials including flammable liquids and solids and corrosives, must be shipped in containers specifically required or authorized by the Department of Transportation (49 CFR 170-179).

(2) *Selection.* When selecting a can or drum, it must be remembered that these containers are structurally rigid in design and are dustproof. They may also be waterproof or water-vaporproof. They are easy to mark and afford excellent physical protection to contents during shipment and storage. Drums may be less susceptible to pilferage than some other types of containers. Care must be taken when selecting containers. This is particularly true when selecting a container for shipment of dangerous items; it is also true when selecting the correct container for other items. *For example*, a square item in a cylindrical container takes about 1½ times the cube required for the same item when packed in a square container. In addition to the loss of valuable cube, excess dunnage is required to fill the voids when a container of the wrong shape is used.

6-2. Spirally Wound Fiber Cans (MIL-C-3955)

a. Description. These cans have metal ends fabricated from terneplate or tinplate and range from 28 to 32 gauge. The body consists of several spirally wound piles of various materials which include greaseproof barrier material, ammunition container board, free aluminum foil, duplex kraft paper, and asphalt impregnated kraft paper. The construction may be of two types. Type I has a single body construction and Type II is of telescopic design (fig 6-1).

b. Classification. Spirally wound cans (MIL-C-3955) are divided into types, grades, styles, and classes.

c. Use. Fiber cans are intended for the protection of items requiring physical, waterproof, or moisture-vaporproof protection. Fiber cans conforming to grade B, Type I, are used for the submethods of preservation IA-13, IC-14, and IIf. Grade B, Type II, meets the requirements for submethod IC-4. In addition, fiber cans are suitable for use as intermediate containers for small unit packs (chap 3).

d. Closure. The closures of spiral wound cans are as follows:

(1) Type I cans are closed by means of a double crimp. Machines for closing these cans may be leased from can manufacturers. After crimping, the metal ends must be smooth, without gathering of metal or paper at the edge of the crimp.

(2) Type II cans are closed and sealed by the application of a strip of tape not less than 1¼ inches wide. The tape must conform to Specification MIL-T-43036. The tape should be centered over the joint between the cover and the body of the can, and the length of the tape should be 1⅓ times the circumference of the can.

6-3. Fiberboard and Paperboard Cans With Paper and Metal Ends (PPP-C-55)

a. Description. These cans are made of spirally or convolutely wound chipboard or kraft paper. They may be lined with moisture-resistant, grease-resistant, or anticorrosive liners such as parchment, glassine, aluminum foil, polyethylene, etc., as required. The cans may be either round, square, or oblong with a variety of covers of either metal or paper (fig 6-2).

b. Classification. Fiberboard and paperboard cans are available in various types, styles, and classes. The sizes of the containers are the sizes which are regularly supplied commercially.

c. Use. These cans are suitable as containers for a wide range of supply items other than liquids. These include food, dry chemicals, drugs, small hardware, and small repair parts. These cans may be used for Method III preservation as established in Specification MIL-P-116 (chap 3).

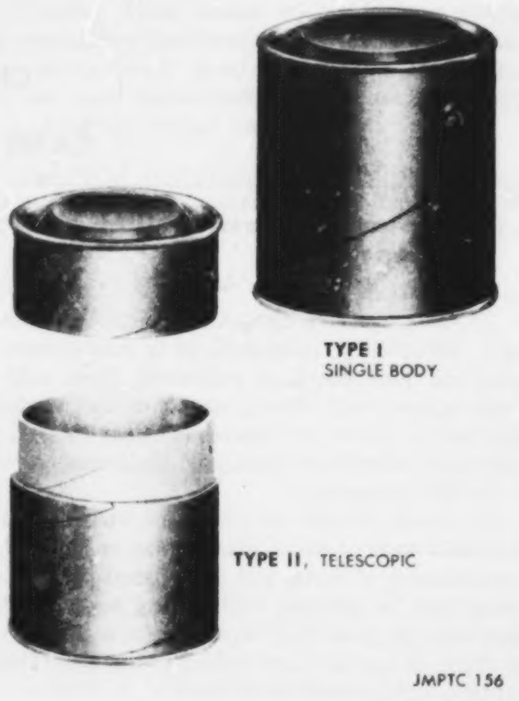


Figure 6-1. Type I and Type II spirally-wound fiber cans.

6-4. Metal Cans, 28 Gage and Lighter (PPP-C-96)

a. Description. These cans are rigid containers made of 28-gage and lighter sheet metal plate. The metal may be either tinplate, terneplate, blackplate, or any combination of these metals. The cans may be round, square, oblong or pear-shaped. They have a variety of closures, such as snap on caps, screwcaps, spout closures, and friction plugs. Several types may be provided with handles when specified. These cans are airtight, dustproof, and water-vaporproof (fig 6-3).

b. Classification. Cans procured under Specification PPP-C-96 are available in several types and classes. Except for Type IX cans, the sizes are commercial sizes unless ordered for a special purpose.

c. Use. Depending upon the class and type, cans meeting the requirements of PPP-C-96 are capable of handling a wide range of contents. Types I, II, III, IV, and VII, Class 2, may be used for the submethods of preservation IA-5, IA-6, and IId as prescribed by MIL-P-116 (chap 8 and fig 6-3). In addition to items packaged for unit protection, other commodities such as foodstuffs, liquids, powders, pastes, and materials

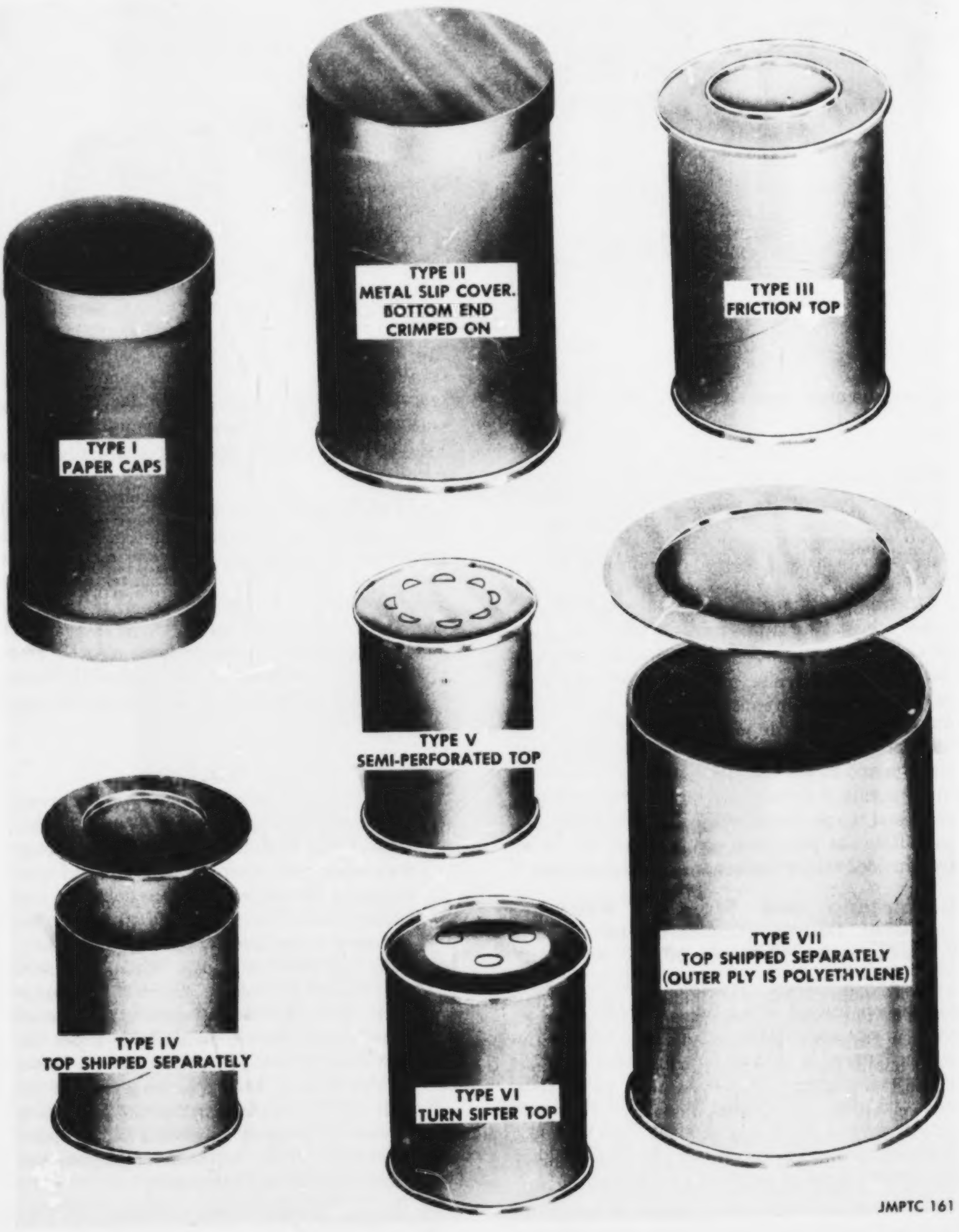

TYPE I
PAPER CAPS
TYPE II
METAL SLIP COVER.
BOTTOM END
CRIMPED ON
TYPE III
FRICTION TOP
TYPE V
SEMI-PERFORATED TOP
TYPE IV
TOP SHIPPED SEPARATELY
TYPE VI
TURN SIFTER TOP
TYPE VII
TOP SHIPPED SEPARATELY
(OUTER PLY IS POLYETHYLENE)
JMPTC 161

Figure 6-2. Styles of fiberboard and paperboard cans.

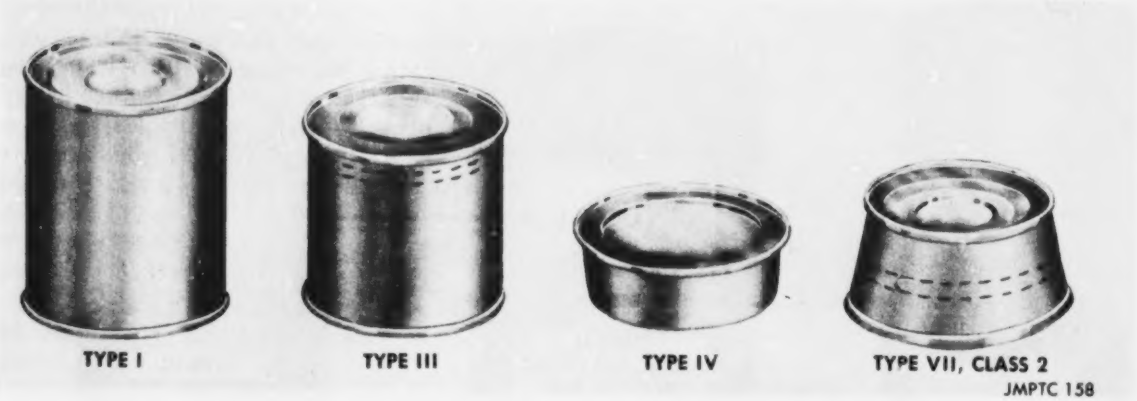


Figure 6-3. Types of metal cans.

which are dispersed under pressure, may be canned also.

CAUTION

> Food products, toilet articles, or medical products may not be placed in cans coated with terneplate. Such cans will be marked "CAUTION—DO NOT USE OR REUSE AS A FOOD CONTAINER."

d. Closure. Closure requirements vary with the type and class of can. Screw caps must be secured by automatic mechanical means or by cap wrenches and may not be hand tightened. Snap on closures are secured by full automatic, semiautomatic, or hand band closing or crimping tools. When specified, after filling the can with the product being packed, multiple friction plugs on 1-gallon and larger containers are spot soldered to the friction ring at three points equidistant from each other around the perimeter of the plug. Other methods of preventing the plug from coming loose will be accepted provided they will meet prescribed drop tests.

6-5. Shipping and Storage, Reusable Metal Drums (Capacity 88 to 510 Cubic Inches) (MIL-D-6055)

a. Description. These reusable metal shipping drums are constructed with a full removable cover secured by a separate exterior locking ring and held in place by a removable nut and bolt. A rubber gasket is supplied to provide a barrier against watervapor. These drums may be fabricated from either aluminum or terneplate steel. They may be made from one piece of metal stamped and drawn to size and shape, or they may be formed of rolled metal with a side seam.

b. Classification. These metal containers are of two types. Type I are formed drums and Type II are drawn. They are furnished in either aluminum alloy, Class A, or steel, Class S. The drums are available in the sizes shown in table 6-1. Each container size and its corresponding cover and locking ring components are identified by a Military Standard part number as listed in the table.

c. Use. The use of these containers is limited to lightweight items. This type of container is used principally for the preservation and packing of such items as delicate instruments, expensive relays, and small electric motors which require Method II preservation, and which may require inspection or lubrication during storage. These containers may also be used for preservation by Method IA and Method II, where the size or weight of the item is too great for the nonreusable sealed can.

NOTE

> The US Postal Service has advised that reusable metal mailing containers with split-ring type closing devices are damaging mail bags and other mail when placed in parcel post channels. The projection of the split-ring and exposed end of the protruding screws cut the canvas or nylon fabric of the bags during handling and while in transit. When containers are handled as "outside" pieces they damage other mail. Split-ring closure type reusable metal containers are nonmailable under the provisions of Section 123.2 of the US Postal Service Manual, unless the projection of the split-ring and exposed end of the protruding screws are properly cushioned and wrapped to prevent injury to postal employees and damage to mail and equipment.

d. Closure. Reusable metal containers are provided with gasketed, full removable covers. The cover, or lid, is held in place by a circumferential locking ring that is secured by means of a nut and bolt (fig 6-4). After

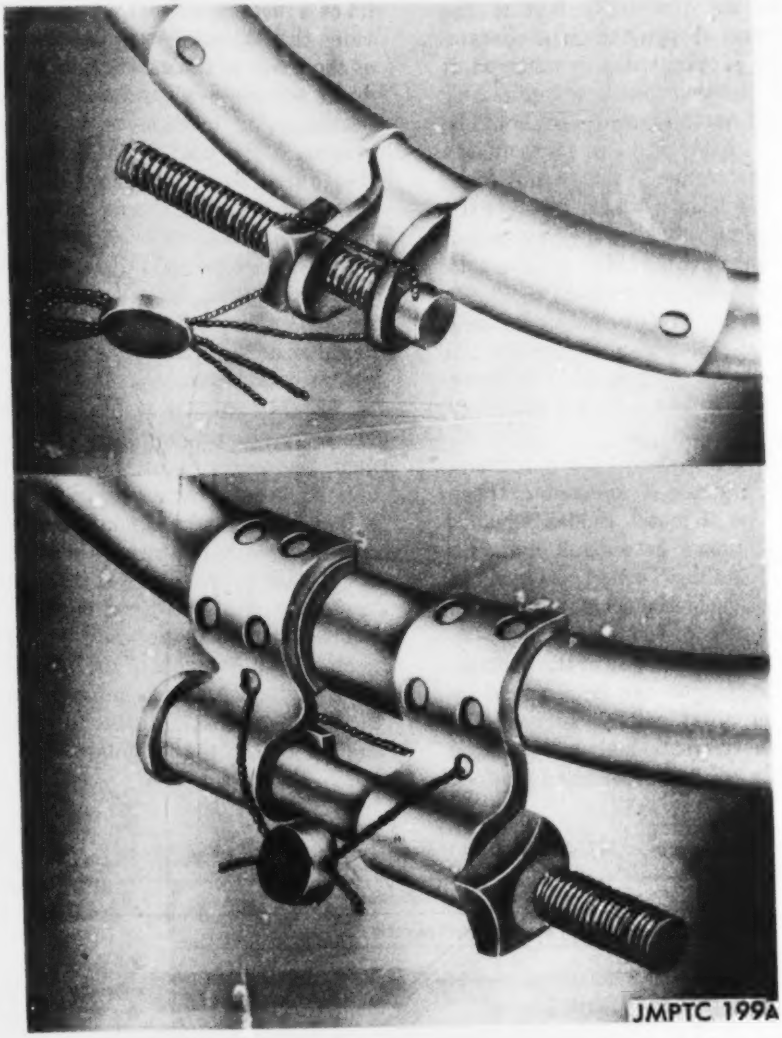


Figure 6-4. Method of closure and sealing reusable drums.

installing the gasket in the cover groove with the flat surface of the gasket outermost, place the cover on the container. Assemble the locking ring to the cover and container. Insert the bolt and tension the nut to a minimum torque pressure of 4 foot-pounds plus or minus ½ foot pound. During the tightening of the nut and bolt, tap the locking ring repeatedly with a rubber, fiber, or plastic mallet, to relieve the friction, thereby assuring a uniform and effective seal. In lieu of the specified torque-indicating device, closure of the container may be accomplished using a common screwdriver having an overall length of 12 inches. If this procedure is followed, a spot check of torque with a torque-indicating device should be made to assure tensioning of the nut and bolt.

e. Sealing. In order that opening or tampering can be readily detectable, seal each container containing serviceable material with a wire and metal seal affixed to prevent opening of the container without destroying the seal. After the closure is completed, insert the sealing wire through the drilled head of the locking ring bolt and the rim of the metal container, draw the wire tight, twist the ends together and apply a metal seal so that the bolt cannot be loosened without breaking the wire or destroying the seal (fig 6-4). Alternatively, the sealing wire should be placed underneath the bolt in the lower hold of the lugs of the locking ring and similarly tightened and sealed. The sealing wire should be tucked under to prevent injury to handling personnel.

f. Conservation, Reuse, and Repair.

(1) *Reusability.* As the reusability feature has been a factor in the general adoption of metal containers for preservation and packing military material, it is of major importance that attention be given to their conservation, repair, and reuse. Special care should be taken to minimize loss of any integral parts of the empty containers. It is recommended that caution be exercised in the repair of reusable containers, since the overall cost of repair and materials should not exceed 65 percent of the purchase price of the container. In the event a minor repair is deemed economical, (2), (3), (4), and (5) below, may be used as a guide. Immediately upon removal of material from metal containers, old markings and tags should be obliterated. The cover, gasket, exterior locking ring, bolt, and nut should be fastened together to prevent loss.

(2) *Damage to body.* The reusable metal containers have bodies which are either soldered or deep drawn from a single piece of metal. Soldered bodies are more susceptible to damage from dents and abrasions incurred in rough handling. Dents in the body of the container affecting the soldered seam, joint, or lip will make the container unfit for furthur use (fig 6-5). Dents other than the above, in the body of the container are considered repairable and can be removed by hammering, pressing, or other suitable means. The painted surfaces are to be retouched or repainted where necessary, and the container returned to stock or reused.

(3) *Damage to cover.* Small dents in the cover or lid of a metal container are considered repairable provided they do not distort the cover or impair assembly of the cover to the gasket or container (fig 6-5). Such dents are removed and bare spots retouched where necessary, in accordance with the preceding paragraphs. If the dent in the cover occurs in the rolled flange that holds the gasket in place, or is otherwise distorted, the cover should be condemned and replaced by a serviceable one from a drum from which a body has been scrapped (fig 6-5). If parts are not available from this source, spares should be requisitioned from stock. In the event that removal of an otherwise repairable dent in the cover results in distortion, the cover should be condemned.

(4) *Damage to gasket.* Proper closure of metal containers to obtain a water-vaporproof seal is dependent upon the condition of the gasket. Consequently, the importance of ascertaining serviceability of the gasket by visual inspection cannot be overemphasized. If the gasket is torn, distorted, weather checked, or deformed due to stretching, it must be replaced by a serviceable one (fig 6-6). Reusability of the gasket, as well as effectiveness of the water-vaporproof seal, depends upon proper assembly of the gasket to the cover and to the container. After assembly to the cover, the flat surface of the gasket must be in position to bear against the rolled lip of the container.

Table 6-1. MIL-D-6055 Drums: Metal Reusable, Shipping and Storage

Steel containers							
	Military standard part number						
Container assembly	Container body	Cover	Locking ring	Gasket	Nominal capacity (cu. in.)	Inside diameter	Inside depth
MS-24347-1	MS-24347-21	MS-24347-41	MS-24347-61	MS-24347-81	88	5	4.5
MS-24347-2	MS-24347-22	MS-24347-41	MS-24347-61	MS-24347-81	167	5	8.5
MS-24347-3	MS-24347-23	MS-24347-42	MS-24347-62	MS-24347-82	149	6.5	4.5
MS-24347-4	MS-24347-24	MS-24347-42	MS-24347-62	MS-24347-82	224	6.5	6.75
MS-24347-5	MS-24347-25	MS-24347-42	MS-24347-62	MS-24347-82	282	6.5	8.5
MS-24347-6	MS-24347-26	MS-24347-43	MS-24347-63	MS-24347-83	340	8.5	6.0
MS-24347-7	MS-24347-27	MS-24347-43	MS-24347-63	MS-24347-83	425	8.5	7.5
MS-24347-8	MS-24347-28	MS-24347-43	MS-24347-63	MS-24347-83	510	8.5	9.0

Note. Add D in place of dash in the part number of aluminum alloy.

(5) *Damage to locking ring.* To insure proper sealing of the gasket to both the cover and the container, the locking ring must exert a uniform clamping pressure. Small dents in the locking ring will impair this function of the ring (fig 6-6). Any attempt to remove such dents is considered impracticable due to the possibility of creating further damage. Consequently, it is necessary to replace locking rings when they are damaged as described above.

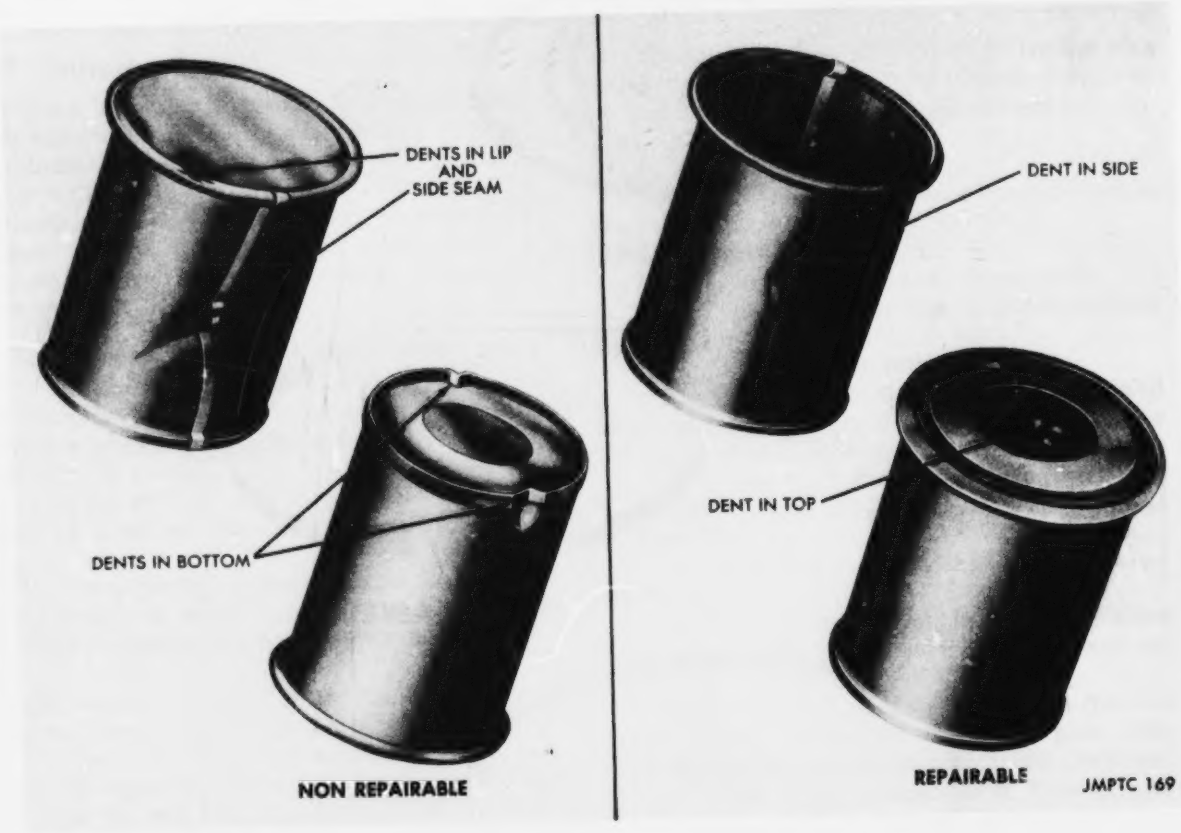

DENTS IN LIP AND SIDE SEAM
DENTS IN BOTTOM
NON REPAIRABLE
DENT IN SIDE
DENT IN TOP
REPAIRABLE
JMPTC 169

Figure 6-5. Nonrepairable and repairable dents in drums.

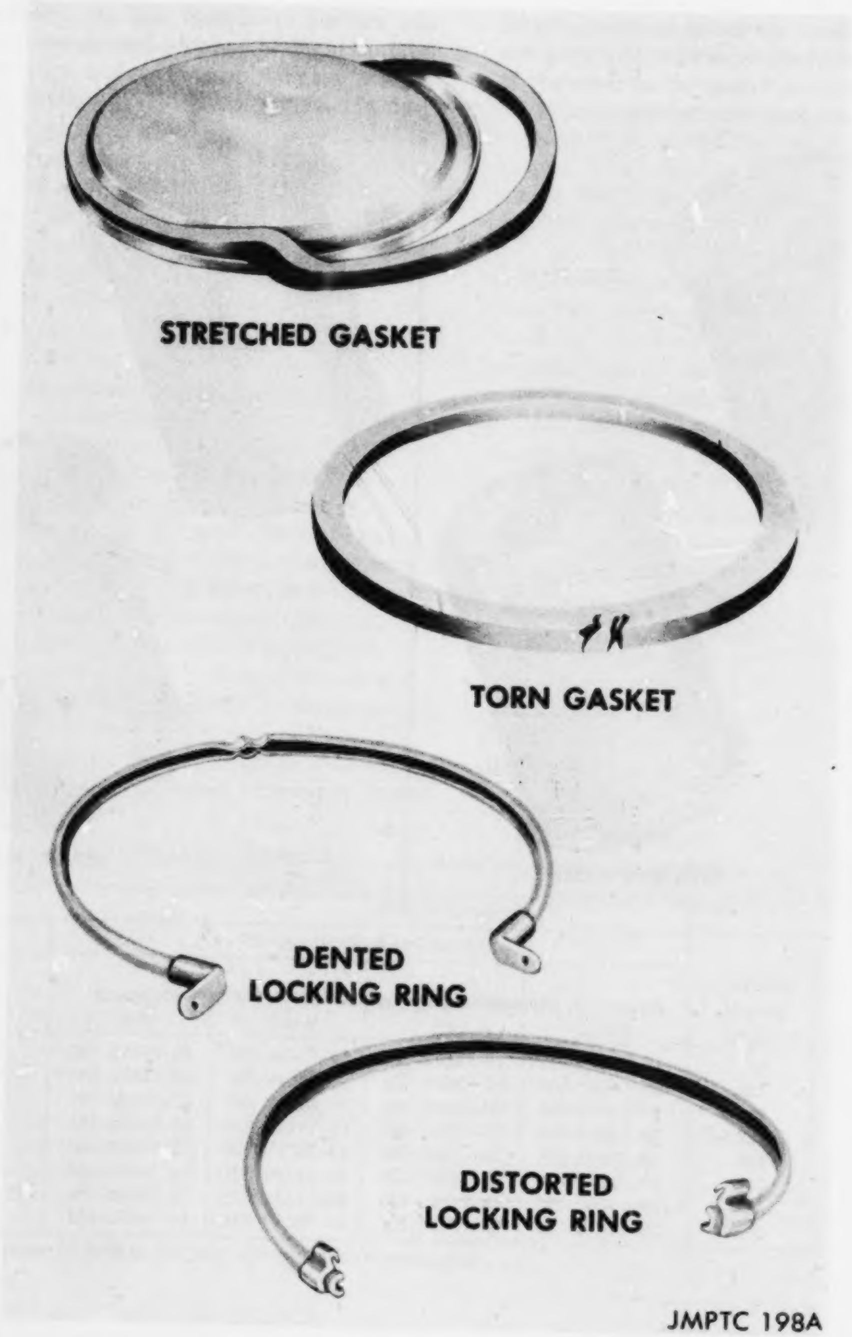

STRETCHED GASKET
TORN GASKET
DENTED LOCKING RING
DISTORTED LOCKING RING
JMPTC 198A

Figure 6-6. Nonrepairable gaskets and locking rings.

CHAPTER 7
REUSABLE CUSHIONED CONTAINERS

7-1. Introduction

There are several systems of containers which were specifically designed as multi-use shipping containers. The Air Force developed a system which utilizes fiberboard boxes with a polyurethane cushioning medium. The Navy version utilizes molded plastic cases with either a polyurethane or suspension system cushioning medium.

7-2. Boxes, Shipping, Reusable, with Cushioning (PPP-B-1672)

a. General. This specification was developed to provide a source of containers to be used in the FAST-PACK system.

b. FAST-PACK is a system which utilizes a family of standard size cushioned shipping containers.

(1) These packs use polyurethane foam cushioning which in most cases is bonded to the container to assure the integrity of the complete pack.

(2) Because of their construction and closure features, these boxes are reusable.

(3) The Fast-Packs are especially useful for return of repairable components since each size and type is suitable for shipment of a large number of different items within certain limits of size, weight, and fragility.

(4) All Fast-Pack containers must be marked by printing or stencilling in black letters, REUSABLE FAST PACK, to alert users that the container must be reused if the integrity of the pack has not been diminished.

c. Material, Types and Styles

(1) Materials for all boxes shall conform to type CF, class WR, of Specification PPP-F-320, Fiberboard, Corrugated and Solid, Sheet Stock (container grade) and Cut Shapes.

(2) Boxes of Type I, Type III and Type IV shall be made of grade V3c material, except for the two largest box sizes of Type III, which require V13c material because of dimensions.

(3) Type II boxes shall be made of material grade W5c.

(4) Cushioning shall be polyurethane conforming to the first article requirements of MIL-P-26514, polyurethane foam, flexible for packaging and shall conform to Type I, Class 2, Grade C for all packs, except for Type II pack cushioning which shall conform to Grade B. Cushioning in Type II packs shall be treated with an antistatic agent and have a static decay rate of 2 seconds or less and shall not increase with age or use.

(5) Types and Styles

(a) There are four types of packs used in the Fast Pack System (fig 7-1).

1. Type I—Vertical Star Pack.

2. Type II—Folding Convoluted Pack.

3. Type III—Telescoping Encapsulated Pack.

4. Type IV—Horizontal Star Pack.

(b) There are five styles of boxes associated with the four types (fig 7-1). The Style describes the construction of the box and its closure.

1. Styles A, B and C are designed as Type I containers. Style B is also designed to conform to Type IV.

a. Style A is the Regular Slotted Container (RSC).

b. Style B is the Double Cover Container (DBLCC), modified so that the covers shall extend to one-half the depth of the tube.

c. Style C is a modified DBLCC in that the joints for the covers and the single piece tube shall be butted and joined with metal fasteners.

2. Style D is designed as a Type II container, it is amodified Triple Slide (TS) Box. The modification is the omission of the middle tube and that the overlap of the sleeve be fastened outside the side panel by stapling and stitching.

3. Style G is the only Type III container. It is modified full telescope box (FTC), in that the inside dimensions of the cover must be extended for ease in the installation and removal of the cover, as shown:

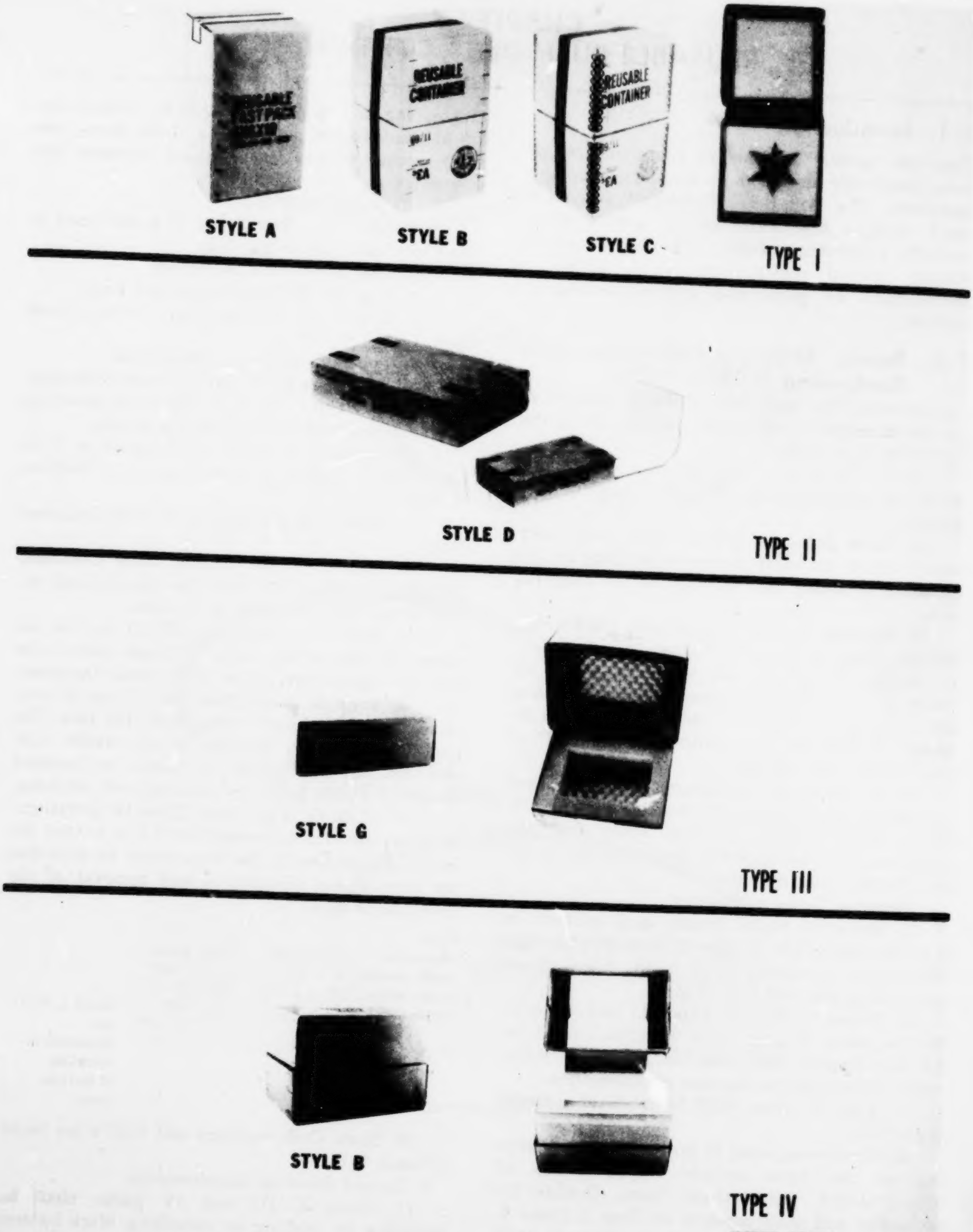
Cover dimension	*V3c grade*	*V13c grade*
Inside length	L + 3/4″	L + 1 1/4″
Inside width	W + 1 1/4″	W + 2″
Inside depth	D + 1/4″	D + 1/2″

where L,W,D are the inside dimensions of the box body.

(6) Sizes, Code numbers and NSN's are listed in Table 7-1.

d. Special Marking Requirements.

(1) Types I, III and IV packs shall be identified by printing or stencilling black letters, not less than 3/4 inches high (the numberals of


REUSABLE FAST PACK
REUSABLE CONTAINER
REUSABLE CONTAINER

STYLE A

STYLE B

STYLE C

TYPE I

STYLE D

TYPE II

STYLE G

TYPE III

STYLE B

TYPE IV

JMPTC 3042A

Figure 7-1. Fast pack containers

the NSN shall be a minimum 3/8 inch high) the following data:

REUSABLE
FAST PACK
(appropriate pack size and cube)
(appropriate NSN)

(2) The marking shall be centered on the uppermost area of two opposite faces of the style A and style G boxes, and on one face of each cap of the style B and style C boxes.

(3) Type II packs require the following markings, in characters not less than 3/8″ high, on the two narrow sides of the box:

REUSABLE FAST PACK
(appropriate pack size and NSN)

(4) Each end of the style D box shall be marked with the words:

PUSH OPEN or PUSH ANTISTATIC OPEN

e. Depots. The criteria listed above apply to depots packaging or represerving and repacking expendable items for shipment and/or storage.

f. Guidelines. Contractors and Depots are encouraged to use advanced packaging technology, and innovative methods or materials for the purpose of effecting packaging economies.

g. Closure

(1) Surfaces to which tape for closure or reinforcement is to be applied must be free of loose soil, oil and/or grease. These surfaces should be wiped clean prior to the application of tape.

(2) Tape applied after the first use should be applied directly over the existing tape.

(3) Loose ends of existing tape should be cut off, not torn loose. Tearing the tape from the box damages the box surface and weakens the container walls.

(4) Recommended closure procedures for each type and style of FAST PACK boxes have been developed to assure reusability to the maximum extent. These are: (fig 7-2).

(a) Level C pack closures.

1 Type I, Style A: One strip of tape 2″ wide conforming to PPP-T-45, Type II, class 1, or PPP-T-60, Type III, class 1, centered on top seam, with 3″ return on each end panel. When required because of weight and/or size, reinforcement will be provided by the application of PPP-T-97, Type II, class B, 1/2 inch wide in accordance with the tape banding requirements of the Appendix to PPP-B-636.

2 Type I, Style B—same as Style C.

3 Type I, Style C: One strip of PPP-T-97, Type II, class B, 1/2″ wide tape, over the top, bottom and both sides, with a minimum 2″ overlap. *Do not tape over marked sides.*

4 Type II, style D: Two strips PPP-T-97, Type II, class B, 1/2″ wide tape over each end, with 2″ return on top and bottom. *Do not tape over "PUSH TO OPEN."*

5 Type III, Style G:

1. One strip of PPP-T-97, Type II, class B, 3/4″ wide tape, applied girthwise, 6″ from each end.

2. For boxes over 14″ wide, apply one additional strip lengthwise, centered over the top, bottom and ends.

6 Type IV: Two girthwise strips of PPP-T-97, Type II, class B, 3/4″ wide tape, placed 6″ from the ends, and two lengthwise strips placed 3″ from the sides.

CAUTION
TAPE APPLIED TO EFFECT CLOSURE OR REINFORCEMENT OF FAST PACK CONTAINERS SHALL NOT OBSCURE PREPRINTED MARKINGS

(b) Level B pack closures. For level B pack, closure, waterproofing, and reinforcing requirements specified in PPP-B-636 apply: Fiberboard fast packs are not intended to meet level A pack requirements.

h. Applications and Use.

(1) These packs are intended for use as standard, exterior, reusable packing media in the preservation, packing, handling, shipping and storage of servicable and repairable items.

(*a*) Type I packs may be used for items such as meters, gauges and instruments.

(*b*) Type II packs may be used for items which are essentially flat (1/4 to 2 1/2 inches thick) such as circuit boards, electronic modules and tubes.

(*c*) Type III packs may be used for blackbox type items such as receiver-transmitters, amplifiers, power supply units and electronic indicators.

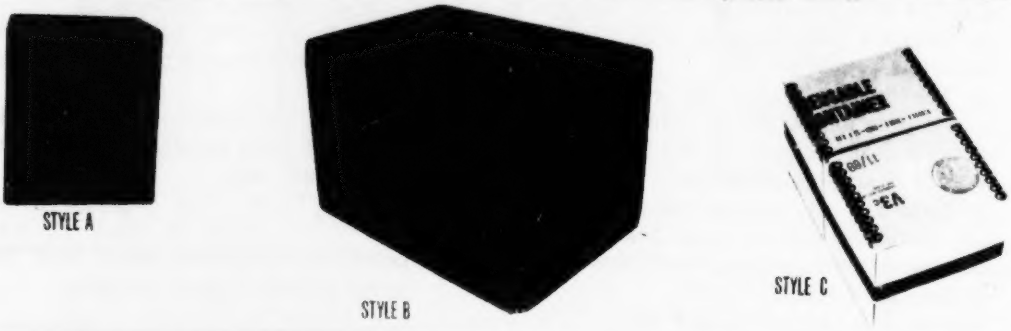
(*d*) Type IV packs may be used for electrical/electronic items generally having a small cross section relative to length, such as control generators, amplifiers, voltmeters, protection panels, transformers and regulators.

(2) Recommended bare items dimensions, item size and weight, methods of pack and tare weight, as well as the MIL-STD-726 code for these boxes are shown in table 7-2.

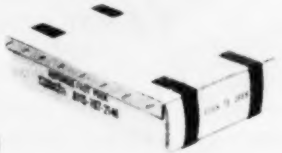
i. Opening Fast Pack Containers (fig 7-2). To assure reusability, cut tape at the seams with a shallow knife. *On Type II, style D contaienrs, do not cut tape along maufacturer's joint. Cut tape only along end seams adjacent to words "PUSH OPEN."*

CAUTION

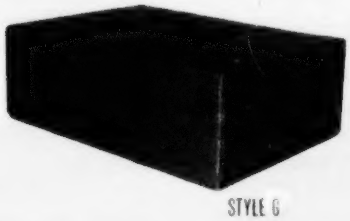
DO NOT TEAR TAPE LOOSE. THIS WILL DAMAGE THE FIBERBOARD AND SHORTEN THE EXPECTED LIFE OF THE CONTAINER.


STYLE A
STYLE B
STYLE C

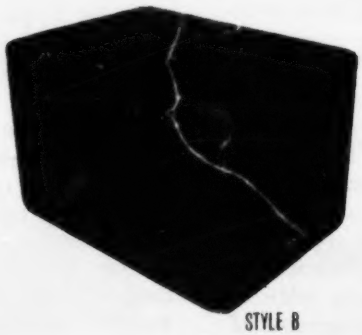
TYPE I



TYPE II



TYPE III



TYPE IV

NOTE: BLACK TAPE USED FOR VISIBILITY

JMPTC 2943B

Figure 7-2. Fast pack closures.

Table 7-1. Fast Pack Code Breakdown

000 *IDENTIFIER*	*4* *CODED TO MIL-P-116 PRESV METHOD*	*X* *"X" ALWAYS APPEARS IN THIS POSITION IN THE FAST PACK NUMBER*	*A* *IDENTIFIES TYPE OF FAST PACK*	*5* *SPECIFIES SIZE OF GIVEN TYPE (SIZE 1 THRU 9)*
ALL FAST PACKS & STD PACKS HAVE THREE NUMERIC ZEROS IN THE FIRST THREE SPACES	CODE 1 = METH III CODE 2 = METH IC1 CODE 3 = METH IA8 CODE 4 = METH IIC CODE 5 = METH I CODE 6 = METH ICI W PRES. CODE 7 = METH IA8 W PRES. CODE 8 = METH IIC W PRES.	THE "X" IDENTIFIES THIS NUMBER AS A FAST PACK NUMBER	A = TYPE I C&D = TYPE II E&F = TYPE III G = TYPE IV	SEE BELOW EACH TYPE FOR SIZES

TYPE I		TYPE II		TYPE III		TYPE IV	
VERTICAL STAR PACK		FOLDING CONVOLUTED PACK		TELESCOPING ENCAPSULATED PACK		HORIZONTAL STAR PACK	
NSN AND FAST PACK NO.	DIM.	NSN AND FAST PACK NO.	DIM.	NSN AND FAST PACK NO.	DIM.	NSN AND FAST PACK NO.	DIM.
8115-00-192-1603		8115-00-787-2142		8115-00-516-0242		8115-01-018-956	
0001XA1		0001XC1		0001XE1		0001XG1	
0002XA1		0002XC1		0002XE1		0002XG1	
0003XA1	6 x 6 x 10	0003XC1	6 x 5 x 2½	0003XE1	30 x 16 x 14	0003XG1	20 x 14 x 14
0004XA1		0004XC1		0004XE1		0004XG1	
0005XA1		0005XC1		0005XE1		0005XG1	
8115-00-192-1604		8115-00-787-2147		8115-00-519-1825		8115-01-006-7257	
0001XA2		0001XC2		0001XE2		0001XG2	
0002XA2		0002XC2		0002XE2		0002XG2	
0003XA2	8 x 8 x 12	0003XC2	6 x 5 x 3½	0003XE2	32 x 12 x 14	0003XG2	22 x 16 x 16
0004XA2		0004XC2		0004XE2		0004XG2	
0005XA2		0005XC2		0005XE2		0005XG2	
8115-00-192-1605		8115-00-101-7647		8115-00-550-3558			
0001XA3		0001XC3		0001XE3			
0002XA3		0002XC3		0002XE3			
0003XA3	10 x 10 x 12	0003XC3	9 x 6 x 2½	0003XE3	24 x 14 x 14		
0004XA3		0004XC3		0004XE3			
0005XA3		0005XC3		0005XE3			
8115-00-134-3655		8115-00-101-7638		8115-00-516-0251			
0001XA4		0001XC4		0001XE4			
0002XA4		0002XC4		0002XE4			
0003XA4	12 x 12 x 14	0003XC4	9 x 6 x 3½	0003XE4	20 x 14 x 9		
0004XA4		0004XC4		0004XE4			
0005XA4		0005XC4		0005XE4			
8115-00-050-5237		8115-00-787-2146		8115-00-550-3574			
0001XA5		0001XC5		0001XE5			
0002XA5		0002XC5		0002XE5			
0003XA5	12 x 12 x 18	0003XC5	12 x 8 x 2½	0003XE5	25 x 14 x 14		
0004XA5		0004XC5		0004XE5			
0005XA5		0005XC5		0005XE5			

Table 7-1. Fast Pack Code Breakdown—Continued

TYPE I		TYPE II		TYPE III		TYPE IV
8115-00-134-3656	14 x 14 x 16	8115-00-787-2148	12 x 8 x 3½	8115-01-105-1315	32 x 18 x 16	
0001XA6		0001XC6		0001XE6		
0002XA6		0002XC6		0002XE6		
0003XA6		0003XC6		0003XE6		
0004XA6		0004XC6		0004XE6		
0005XA6		0005XC6		0005XE6		
		8115-01-019-4085	18 x 12 x 2½	8115-01-015-1312	24 x 18 x 16	
		0001XC7		0001XE7		
		0002XC7		0002XE7		
		0003XC7		0003XE7		
		0004XC7		0004XE7		
		0005XC7		0005XE7		
		8115-01-019-4084	18 x 12 x 3½	8115-01-015-1313	26 x 9 x 9	
		0001XC8		0001XE8		
		0002XC8		0002XE8		
		0003XC8		0003XE8		
		0004XC8		0004XE8		
		0005XC8		0005XE8		
		8115-01-057-1244	10 x 10 x 3½	8115-01-015-1314	34 x 24 x 18	
		0001XC9		0001XE9		
		0002XC9		0002XE9		
		0003XC9		0003XE9		
		0004XC9		0004XE9		
		0005XC9		0005XE9		
		8115-01-057-1243	13 x 13 x 3½	8115-01-094-6520	30 x 27 x 14	
		0001XD1		001XF1		
		0002XD1		002XF1		
		0003XD1		003XF1		
		0004XD1		004XF1		
		0005XD1		005XF1		
		8115-01-057-1245	16 x 16 x 3½			
		0001XD2				
		0002XD2				
		0003XD2				
		0004XD2				
		0005XD2				
		8115-01-093-3730	24 x 16 x 3½			
		001XD3				
		002XD3				
		002XD3				
		004XD3				
		005XD3				

Table 7-2. Fast Pack Containers

Container size ID and pack NSN	Optimum item size and weight	Method	Code	Desct unit
SPEC PPP-B-1672 VERTICAL STAR PACK TYPE I (MIL-STD-726 code NR)				
6 x 6 x 10	3 dia. x 6	III	10	00
(8115-00-192-1603)	3 lbs	1C1	2E	00
	3 x 3 x 6	1A8	3G	00
	4 lbs	IIC	4G	3
		I	11	00
8 x 8 x 12	4 dia x 8	III	10	00
(8115-00-192-1604)	5.0 lbs	1C1	2E	00
	5 dia x 8	1A8	3G	00
	4 x 4 x 8	IIC	4G	4
	7 lbs	I	11	00
10 x 10 x 12	5 dia x 6	III	10	00
(8115-00-192-1605)	6.0 lbs	1C1	2E	00
	5 x 5 x 6	1A8	3G	00
	9 lbs	IIC	4G	4
	6 dia x 6	I	11	00
	7 lbs			
	4 dia x 6			
	5 lbs			
12 x 12 x 14	6 dia x 8	III	10	00
(8115-00-134-3655)	13 lbs	1C1	2E	00
	5 dia x 8	1A8	3G	00
	8.5 lbs	IIC	4G	6
	5 x 5 x 10	I	11	00
	11 lbs			
	6 x 6 x 8			
	12 lbs			
12 x 12 x 18	6 dia x 10	III	10	00
(8115-00-050-5237)	16 lbs	1C1	2E	00
	5 x 5 x 10	1A8	3G	00
	13 lbs	IIC	4G	8
	5 dia x 10	I	11	00
	11 lbs			
	6 x 6 x 10			
	20 lbs			
14 x 14 x 16	7 dia x 10	II	10	00
(8115-00-134-3656)	16 lbs	1C1	2E	00
	6 dia x 10	1A8	3G	00
	15 lbs	IIC	4G	8
	6 x 6 x 10	I	11	00
	12 lbs			
	7 x 7 x 10			
	23 lbs			
SPEC PPP-B-1672 FOLDING CONVOLUTED PACK TYPE II (MIL-STD-726 Code NS)				
6 x 5 x 2½	5 x 4½ x 1¼	III	10	00
(8115-00-787-2142)	0.5 lbs	1C1	2E	00
		1A8	3G	00
		IIC	4G	3
		I	11	00
6 x 5 x 3½	5 x 4½ x 2¼	III	10	00
(8115-00-787-2147)	1.0 lbs	1C1	2E	00
		1A8	3G	00
		IIC	4G	3
		I	11	00
9 x 6 x 2½	8 x 5½ x 1¼	III	10	00
(8115-00-101-7647)	0.9 lbs	1C1	2E	00
		1A8	3G	00
		IIC	4G	4
		I	11	00
9 x 6 x 3½	8 x 5½ x 2¼	III	10	00
(8115-00-101-7638)	1.8 lbs	1C1	2E	00

Table 7-2. Fast Pack Containers—Continued

Container size ID and pack NSN	Optimum item size and weight	Method	Code	Desct unit
		1A8	3G	00
		IIC	4G	4
		I	11	00
12 x 8 x 2½	11 x 7½ x 1¼	III	10	00
(8115-00-787-2146)	1.8 lbs	1C1	2E	00
		1A8	3G	00
		IIC	4G	5
		I	11	00
12 x 8 x 3½	11 x 7½ x 2¼	III	10	00
(8115-00-787-2148)	3.6 lbs	1C1	2E	00
		1A8	3G	00
		IIC	4G	6
		I	11	00
18 x 12 x 2½	17 x 11½ x 1¼	III	10	00
(8115-01-019-4085)	4.3 lbs	1C1	2E	00
		1A8	3G	00
		IIC	4G	7
		I	11	00
18 x 12 x 3½	17 x 11½ x 2¼	III	10	00
(8115-01-019-4084)	8.6 lbs	1C1	2E	00
		1A8	3G	00
		IIC	4G	8
		I	11	00
10 x 10 x 3½	9 x 9½ x 2¼	III	10	00
(8115-01-057-1244)	1.8 lbs	1C1	2E	00
		1A8	3G	00
		IIC	4G	6
		I	11	00
13 x 13 x 3½	12 x 12½ x 2¼	III	10	00
(8115-01-057-1243)	4.3 lbs	1C1	2E	00
		1A8	3G	00
		IIC	4G	7
		I	11	00
16 x 16 x 3½	15 x 15½ x 2¼	III	10	00
(8115-01-057-1245)	8.6 lbs	1C1	2E	00
		1A8	3G	00
		IIC	4G	8
		I	11	00
24 x 16 x 3½	23 x 15 x 2¼	III	10	00
(8115-01-093-3730)	10 lbs	1C1	2E	00
		1A8	3G	00
		IIC	4G	10
		I	11	00
SPEC PPP-B-1672 TELESCOPING ENCAPSULATED PACK TYPE III (MIL-STD-726 Code NV)				
30 x 16 x 14	24 x 11 x 9	III	10	00
(8115-00-516-0242)	54 lbs	1C1	2E	00
		1A8	3G	00
		IIC	4G	24
		I	11	00
32 x 12 x 14	26 x 6 x 8	III	10	00
(8115-00-519-1825)	33 lbs	1C1	2E	00
		1A8	3G	00
		IIC	4G	20
		I	11	00
24 x 14 x 14	18 x 8 x 8	III	10	00
(8115-00-550-3558)	38 lbs	1C1	2E	00
		1A8	3G	00
		IIC	4G	16
		I	11	00
20 x 14 x 9	16 x 10 x 5	III	10	00
(8115-00-516-0251)	8 lbs	1C1	2E	00
		1A8	3G	00

Table 7-2. Fast Pack Containers—Continued

Container size ID and pack NSN	Optimum item size and weight	Method	Code	Desct unit
		IIC	4G	16
		I	11	00
25 x 14 x 14 (8115-00-550-3574)	13 x 7 x 7 19 lbs	III	10	00
		1C1	2E	00
		1A8	3G	00
		IIC	4G	12
		I	11	00
32 x 18 x 16 (8115-01-015-1315)	24 x 13 x 11 80 lbs	III	10	00
		1C1	2E	00
		1A8	3G	00
		IIC	4G	24
		I	11	00
24 x 18 x 16 (8115-01-015-1312)	18 x 13 x 11 50 lbs	III	10	00
		1C1	2E	00
		1A8	3G	00
		IIC	4G	24
		I	11	00
26 x 9 x 9 (8115-01-015-1313)	20 x 5 x 5 90 lbs	III	10	00
		1C1	2E	00
		1A8	3G	00
		IIC	4G	12
		I	11	00
34 x 24 x 18 (8115-01-015-1314)	35 x 18 x 12 90 lbs	III	10	00
		1C1	2E	00
		1A8	3G	00
		IIC	4G	36
		I	11	00
30 x 27 x 14 (8115-01-094-6520)	18 x 18 x 5 50 lbs	III	10	00
		1C1	2E	00
		1A8	3G	00
		IIC	4G	34
		I	11	00
SPEC PPP-B-1672 HORIZONTAL STAR PACK TYPE IV MIL-STD-726 Code (NW)				
20 x 14 x 14 (8115-01-010-8956)	14 x 6 x 6 15 lbs	III	10	00
		1C1	2E	00
		1A8	3G	00
		IIC	4G	12
		I	11	00
22 x 16 x 16 (8115-01-006-7257)	16 x 7 x 7 24 lbs	III	10	00
		1C1	2E	00
		1A8	3G	00
		IIC	4G	16
		I	11	00

7-3 Containers, Plastic Reusable Shipping and Storage.

a. General. These multi-application containers were designed by the Navy Aviation Supply Office (ASO) for RFI and retrograde shipment and storage of depot level repairables anywhere in the world via any mode of transportation. The containers described herein meet Air Transport Association (ATA) 300, Category I specifications and will withstand a minimum of 100 trips, thus providing life cycle cost effective protection. There are twenty nine different sizes of plastic reusable containers with a total or more than 20,000 applications. Simplicity of item removal from the container make these the easiest of all containers to use, thereby ensuring proper item protection and promotion uniformity and standardization in packaging, while providing a safety factor at DOD field activities where dedicated, knowledgeable packaging personnel are not always available. A cushioning or suspension system is built into each container. These containers are the state-of-the-art in repairables packaging management. A new series of containers is being developed for storage aboard ship. These containers will be fabricated from flame resistant materials which will be self extinguishing. Shock mounts will be incorporated to provide a 45G protection.

b. Table 7-3 reflects the three types of commonly used modular plastic reusable containers. They are:

(1) MIL-STD-726 Code "NY," ASO Drawing Number 13623 (Figure 7-3). Used for circuit card assemblies and small, non-fragile modules.

(2) MIL-STD-726 Code "NZ," ASO Drawing Number 13414 (Figure 7-4). For major repairables. Protection to forty (40) G shock level.

(3) MIL-STD-726 Code "MY," ASO Drawing Number 15024 (Figure 7-5) and 15345 (Figure 7-6). For gyroscopic instruments and other fragile/delicate repairables. Protection to fifteen (15) G's.

(4) ASO Drawing Number 15450 (Figure 7-7). Non-flammable container to replace #13414.

c. Closure.

(1) 13623 containers are banded with PPP-T-97 tape with minimum one (1) inch overlap. Tape banding guides are molded into the container for easy placement.

(2) 13414, 15024, 15345 and 15450 containers are closed with quarter turn type fasteners permanently affixed to the container.

Table 7-3. Molded Reusable Container

Container Size ID (in.) (National Stock Number)	Recommended max. load size (in.)	Range item weight (lbs)	Maximum shock (G's) transmitted to item	Recommended use
Drawing No. 13623 (MIL-STD-726, Code NY)				
11.25 x 8.25 x 2.125 (8145-00-260-9556)	8.5 x 6.0 x 1.0	0 - 3	Not applicable	Circuit cards and modules
11.25 x 8.75 x 4.5 (8145-00-260-9548)	8.5 x 6.0 x 3.25	0 - 3	Not applicable	
13.25 x 10.75 x 2.125 (8145-00-260-9559)	10.5 x 8.0 x 1.00	0 - 4	Not applicable	
13.25 x 10.75 x 4.5 (8145-00-260-9562)	10.5 x 8.0 x 3.25	0 - 4	Not applicable	
6.75 x 5.0 x 2.0 (8145-01-014-0440)	5.0 x 3.0 x 1.0	0 - 2	Not applicable	
19.75 x 13.75 x 4.5 (8145-02-012-4088)	17.0 x 11.0 x 262	0 - 4	Not applicable	
Drawing No. 13414 (MIL-STD-726, Code NZ)				
10 x 10 x 14 (8145-00-301-2987)	4 x 4 x 8	6.0	40 - 50	Major Repairables
10 x 10 x 18 (8145-00-288-1396)	4 x 4 x 12	7.0	40 - 50	
14.5 x 13 x 10 (8145-00-553-1539)	8.5 x 7 x 4	9.0	40 - 50	
14 x 14 x 12 (8145-00-519-6384)	8 x 8 x 6	11.0	40 - 50	
12 x 12 x 18 (8145-00-288-1397)	6 x 6 x 12	11.0	40 - 50	
20 x 13 x 12 (8145-00-485-8256)	14 x 7 x 6	17.0	40 - 50	
16 x 16 x 15 (8145-00-522-6907)	10 x 10 x 9	20.0	40 - 50	
18 x 14.5 x 19 (8145-00-499-8424)	12 x 8.5 x 13	25.0	40 - 50	
22.5 x 21 x 11.5 (8145-01-044-3289)	16.5 x 15 x 5.5	33.0	40 - 50	
22 x 16 x 17 (8145-00-540-1762)	16 x 10 x 11	31.3	40 - 50	
29 x 14.5 x 14 (8145-00-501-9138)	23 x 8.5 x 8	28.0	40 - 50	

Table 7-3. Molded Reusable Container—Continued

Container Size ID (in.) (National Stock Number)	Recommended max. load size (in.)	Range item weight (lbs)	Maximum shock (G's) transmitted to item	Recommended use
Drawing No. 13414 (MIL-STD-726, Code NZ)				
28 x 18 x 13 (8145-00-549-6647)	22 x 12 x 7	35.0	40 - 50	
34 x 18 x 15 (8145-00-536-4925)	28 x 12 x 9	44	40 - 50	
30 x 18 x 19 (8145-00-449-8427)	24 x 12 x 13	50	40 - 50	
22.5 x 21 x 22.5 (8145-00-499-9808)	16.5 x 15 x 16.5	55	40 - 50	
27 x 27 x 17 (8145-00-485-8250)	21 x 21 x 11	70	40 - 50	
34 x 24 x 17 (8145-00-514-2798)	28 x 18 x 11	78	40 - 50	
28 x 24.5 x 20.5 (8145-00-026-2369)	22 x 18.5 x 14.5	80	40 - 50	
40 x 24 x 18 (8145-00-529-8585)	34 x 18 x 12	85	40 - 50	
36 x 20 x 27 (8145-01-008-3683)	30 x 14 x 21	120	40 - 50	
27 x 27 x 32 (8145-01-010-3776)	21 x 21 x 16	110	40 - 50	

Table 7-3. Molded Reusable Container—Continued

Container Size ID (in.) (National Stock Number)	*Max. load size without handling case (in.)	Handling case, OD (National Stock No.)	Item size using handling case	Item weight (lbs)	Maximum shock (G's) transmitted to item	Recommended use
Drawing No. 15024 (MIL-STD-726, Code MY) 30 x 26.38 x 25.5 (8145-01-016-3451)	13 x 9 x 8	10.38 x 6.5 x 6.5 (8145-01-016-3453)	max length - 8.38 max width - 4.5 depth min - 1.69 max - 3.75	0.5-10.5	15	Gyroscopic instruments
		12.5 x 7.25 x 8 (8145-01-016-3454)	max length - 10.5 max width - 5.25 depth min - 3.25 max - 5.25	0.5-10.5	15	
		14 x 10.38 x 9.75 (8145-01-016-3455)	max length - 12 max width - 8.38 depth min - 5 max - 7	0.5-10.5	15	
35 x 27 x 30 (8145-01-016-3452)	17.5 x 12.25 x 13	18 x 12.25 x 11.75 (8145-01-016-3456)	max length - 16 max width - 10.25 depth min - 6.9 max - 9	8-40	15	
		19 x 14 x 14.25 (8145-01-016-3445)	max length - 17 max width - 12 depth min - 9.5 max - 11.5	8-40	15	

Table 7-3. Molded Reusable Container—Continued

Container Size ID (in.) (National Stock Number)	Recommended max. load size (in.)	Range item weight (lbs)	Maximum shock (G's) transmitted to item	Recommended use	Desiccant Units (when read)
Drawing No. 15345					
35.5 x 29.5 x 33 (8145-01-080-6707)	17 x 10 x 10 (min) 23 x 17 x 17 (max)	35 - 75	15	Gyroscopic Instruments	20
41.4 x 37.3 x 39.3 (8145-01-081-7934)	20 x 15 x 15 (min)	60 - 125	15	Gyroscopic Instruments	40
Drawing No. 15450					
18 x 14 x 12	8 x 4 x 4 (min) 12 x 8 x 6 (max)		45	Major Repairables When Flammability is Storage problem	
20 x 18 x 15	12 x 8 x 6 (min) 14 x 12 x 9 (max)	10 - 20	45		
22.5 x 22.5 x 16	14 x 12 x 7 (min) 16.5 x 16.5 x 10 (max)	15 -30	45		
34 x 19 x 18	14 x 12 x 9 (min) 28 x 13 x 12 (max)	20 - 40	45		
22 x 5 x 22.5 x 21	14 x 14 x 10 (min) 16.5 x 16.5 x 10 (max)	30 - 60	45		
34 x 27 x 20.5	14 x 14 x 10 (min) 28 x 21 x 14.5 x 14.5 (max)	30 - 60	45		
40 x 27 x 20	25 x 14 x 10 (min) 34 x 21 x 14 (max)	45 - 75	45		
34 x 27 x 27	20 x 14 x 14 (min) 28 x 21 x 21 (max)	60 - 100	45		

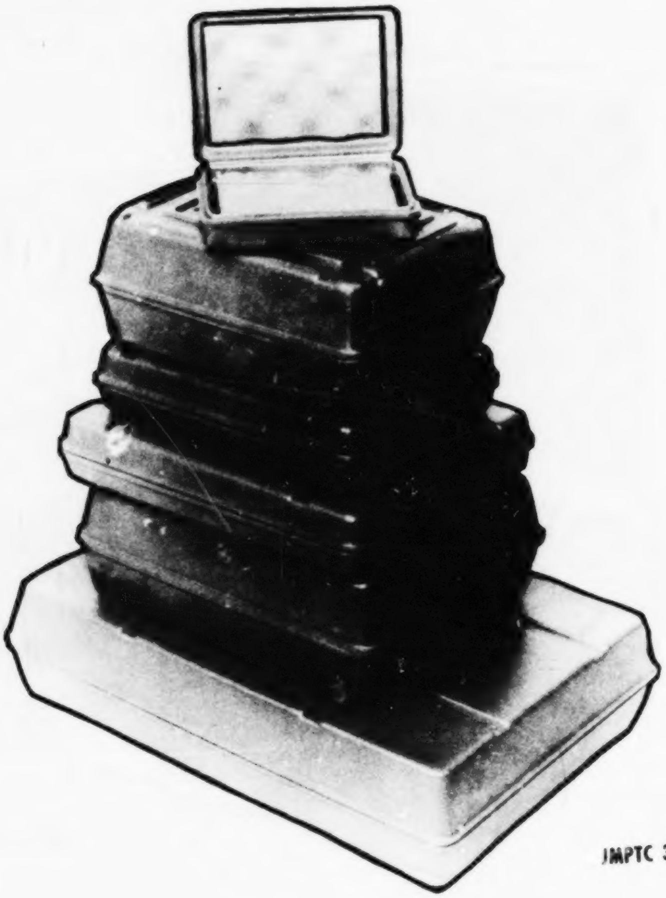


Figure 7-3. Container, Drawing Number 13623

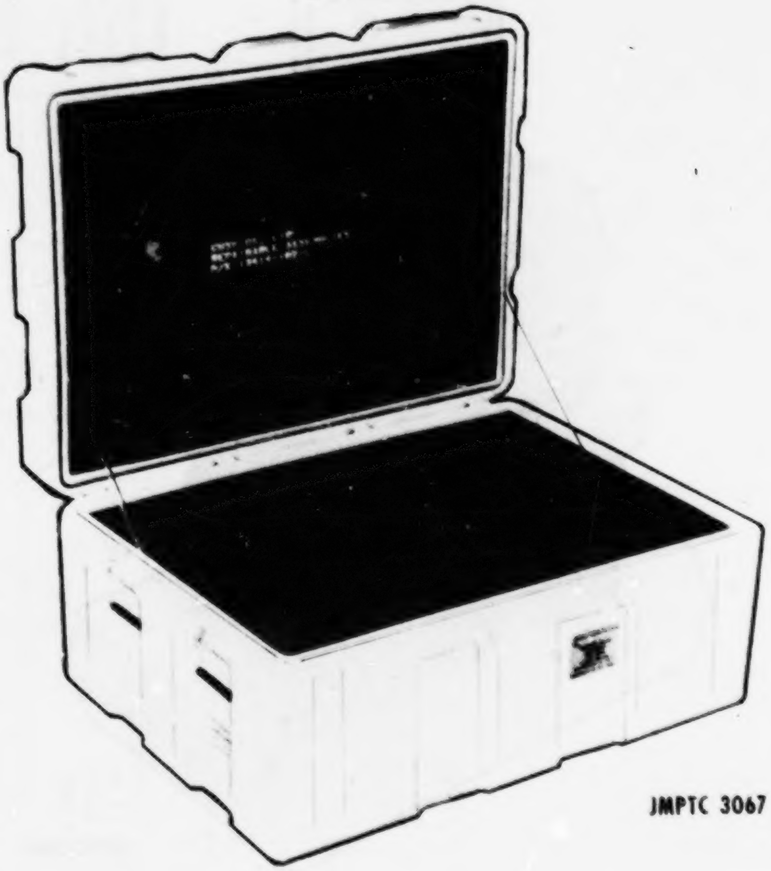


Figure 7-4. Container, Drawing Number 13414

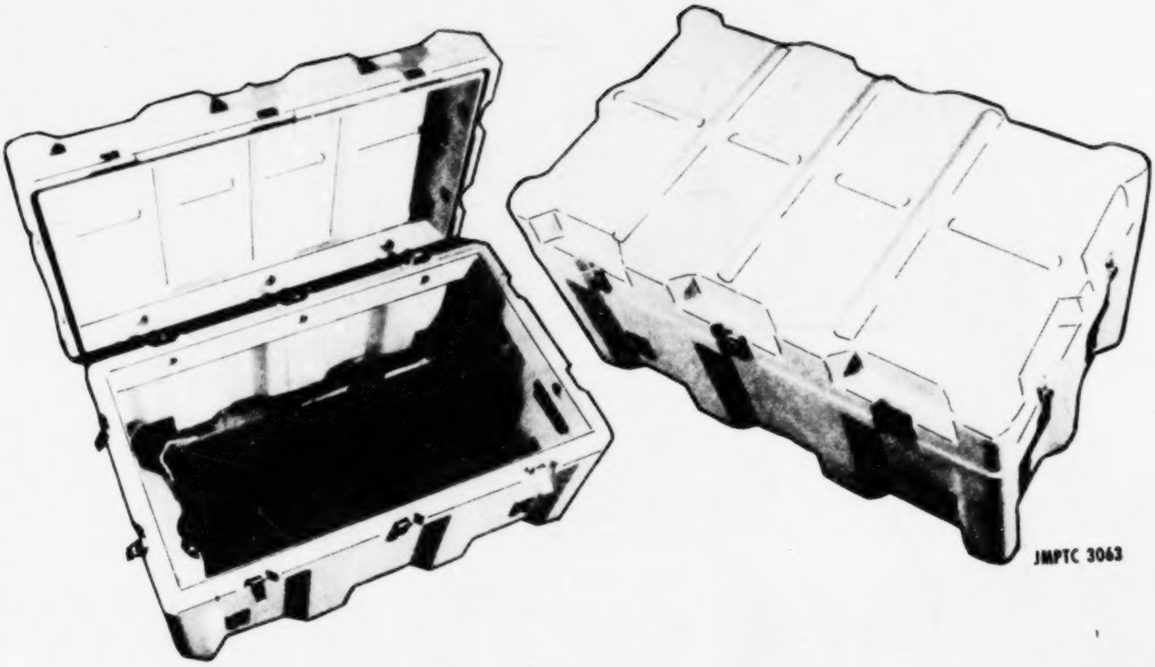


Figure 7-5. Container, Drawing Number 15024

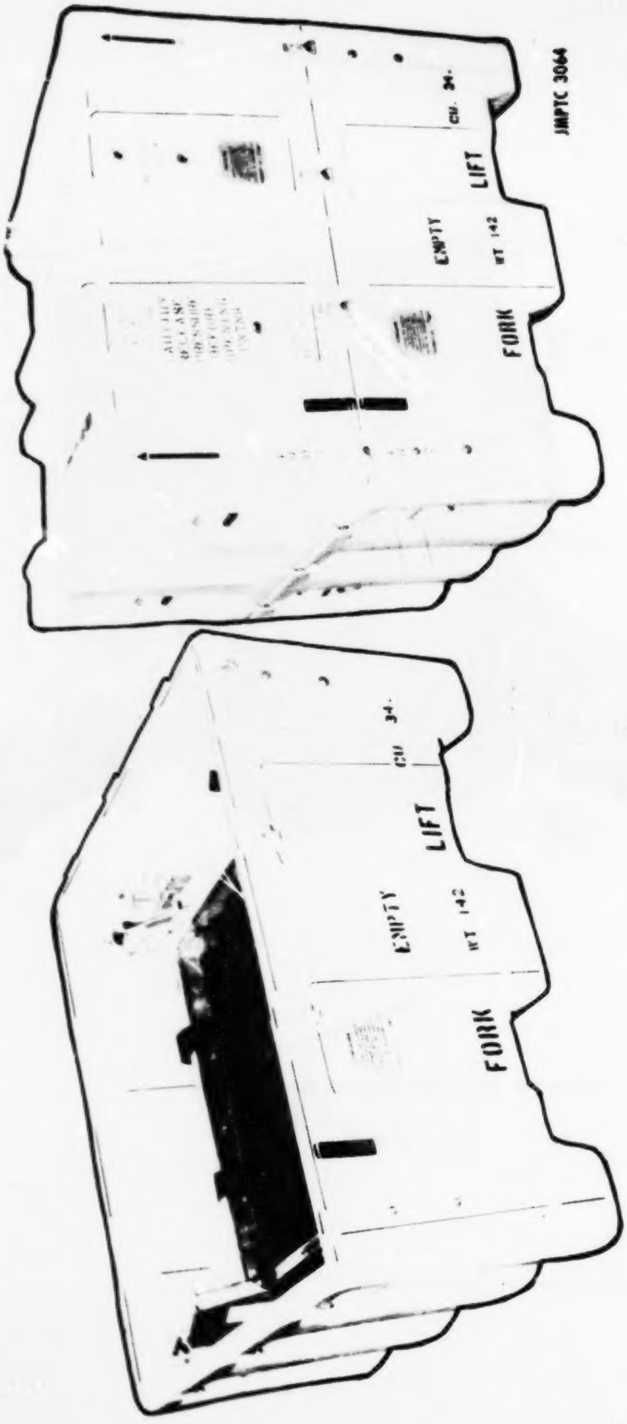
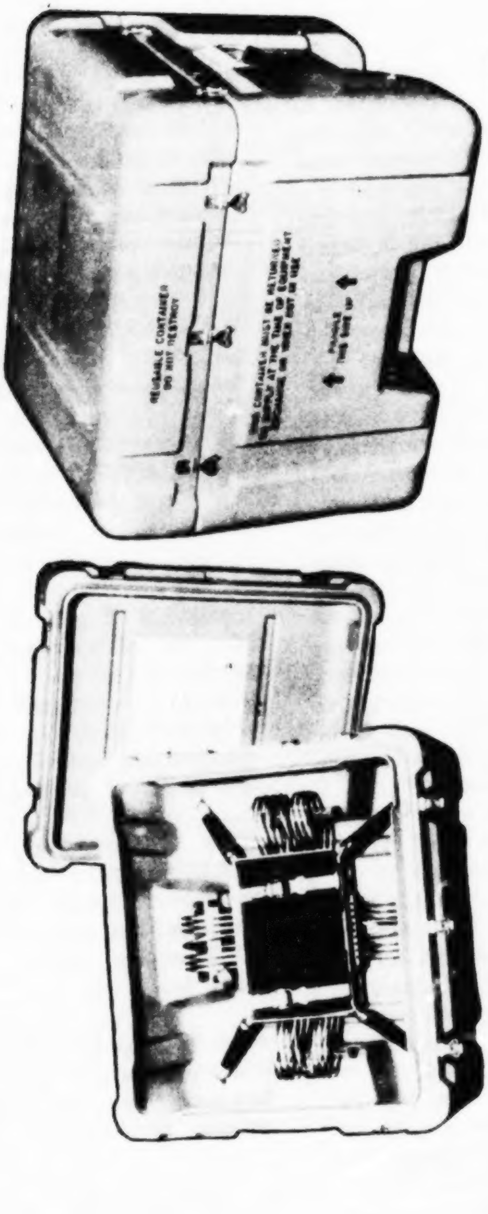

JMPTC 3064
FORK
EMPTY
WT 142
LIFT
CU 34
FORK
EMPTY
WT 142
LIFT
CU 34

Figure 7-6. Container, Drawing Number 15945


REUSABLE CONTAINER
DO NOT DESTROY
THIS CONTAINER MUST BE RETURNED
TO SUPPLY AT THE TIME OF EQUIPMENT
EXCHANGE OR WHEN NOT IN USE
HANDLE
THIS SIDE UP

JMPTC 3065

Figure 7-7. Container, Drawing Number 15450

CHAPTER 2
INDUSTRIAL/COMMERCIAL PACKAGING

8-1. Applicability

a. The US Army Materiel Readiness and Development Command (DARCOM) has authorized the use of industrial/commercial packaging in the procurement of supplies and equipment, exclusive of ammunition, explosives and hazardous materials, for consumption by CONUS posts, camps, depots and contractors, as well as Direct Support (DSS) shipments CONUS and OCONUS.

b. Navy, Air Force, Marine Corps and DLA may prescribe industrial/commercial packaging when such packaging meets the protection requirements of any particular shipment.

c. ASTM D 3951-82 Standard Practice for Commercial Packaging or NAS 855 Industrial Packaging Standard will be referenced in procurement documents when applicable.

8-2. Definition.

a. Industrial/Commercial Packaging is defined as the methods and materials used by the supplier to satisfy the requirements of the industrial/commercial and DoD distribution systems.

b. As defined, Industrial/Commercial Packaging must protect items against physical and environmental damage during shipment, handling and storage.

c. Industrial/Commercial Packaging, in accordance with AR 700-15, NAUSUPINST 4030.28B, AFR 71-6, MCO 4030.33B, DLAR 4145.7, excludes bulk practices used in inter and intraplant shipments to repackaging jobbers and parts distribution outlets, unless they are usual trade practices.

d. Industrial/Commercial Packaging neither demands nor prohibits the use of military or federal specification packaging materials, unit packing or MIL-STD-129 marking. For marking requirements see para. 8-3*g*.

8-3. Requirements of ASTM D 3951-82 or NAS 855

a. Cleanliness. Items shall be free from dirt and contaminants which would contribute to deterioration of the item or which would require cleaning by the customer prior to use. Coating and preservatives applied to the item for protection during shipment are not considered contaminants.

b. Preservative. Items susceptible to corrosion or deterioration shall be provided protection such as preservative coatings, electrostatis barriers, volatile corrosion inhibitors, waterproof/watervaporproof barriers, or desiccant unit packs.

c. Cushioning. Items requiring protection from physical and mechanical damage or which are fragile in nature shall be protected by wrapping, cushioning, pack compartmentization, cartonizing, or other means to mitigate shock and vibration during handling and shipment.

d. Quantity per Unit Pack. Quantity shall be one or more of the same item, a kit, or assembly with loose parts. The number per unit pack shall be the same as that used in industrial/commercial distribution or over-the-counter sales.

e. Packing. Unit and Intermediate packs shall be placed in exterior shipping containers that meet common carrier acceptance and provide safe delivery to destination at lower rates. Unit and intermediate packs which conform to these requirements need no supplemental protection.

f. Marking. Unless otherwise specified, unit, intermediate (when provided) and exterior packs shall, as a minimum, be marked as follows by any means which provides legibility and durability.

(1) National Stock Number (NSN) or part number when NSN is not available.

(2) Noun nomenclature.

(3) Quantity and unit of issue.

(4) Contract, purchase order or delivery order number.

(5) Additional markings as required by the contract.

(6) Shelf life, cure date, or expiration date markings.

(7) Exterior shipping containers shall be marked with the appropriate address and caution marking except for full carloads or full truckloads to a single CONUS consignee.

g. Documentation. One copy of the shipping document (two on multi-item shipments) shall be attached to outside of the container preferably in a waterproof document envelope.

8-4. Application (Army Regulation (AR) 746-1)

a. Procurement. For Army purchases, commercial packaging is authorized for the procurement of all expendable items except:

(1) International Logistics
(2) Special Reserve stocks
(3) Ammunition/hazardous materials
(4) Shipments to Thailand
(5) Missile support elements
(6) Items requiring other considerations due to physical characteristics.

b. Non-Expendable Items. Industrial/Commercial packaging is authorized for procurement of nonexpendable items on an item-by-item basis when *all* of the following three conditions have been met:

(1) It is economically cost-effective; and

(2) Logistical policy requirements will be fully satisfied, and

(3) Technical design details of the industrial/commercial package meet all requirements of the military level of protection A, B, or C as applicable.

APPENDIX A
SELECTION GUIDE

A-1. Purpose

This appendix provides information assistance in the selection of appropriate flexible barriers and wrapping materials for preparing unit packs according to the requirements of MIL-P-116.

A-2. Materials

The number and variety of flexible barriers and wrapping materials specified herein are considered adequate to preserve and unit pack the majority of general supplies, exclusive of any special requirements for transparent or electrostatic-free barriers. Those transparent flexible barriers specified herein are included either because they are the least expensive (L-P-378, 4 and 6 mils) or because there is no other available material meeting all of the requirements of MIL-P-116 (MIL-B-22191, Type I). They were not specifically included to provide transparent packing. Ten materials, identified by numbers 1 through 10 are specified. Each of the materials is designed to perform one or more specific preservation and unit packing functions. These materials are the least expensive available providing the protection required in accordance with MIL-P-116. A list of these ten materials, with a brief description of each, is given in the following table:

Table A-1. Flexible Barrier and Wrapping Materials

Material No.	Description	Specification
1	Kraft paper, 30 pound basis weight, not to be used for non-corrosive applications	UU-P-268
2	Kraft paper, 60 pound basis weight, not to be used for noncorrosive applications	UU-P-268
3	Type I, 50 pound basis weight, for noncorrosive applications	MIL-P-17667
4	Waterproof, greaseproof barrier, grade A, type II, class 1, noncorrosive	MIL-B-121
5	Waterproof, greaseproof barrier, grade A, type I, class 1, noncorrosive	MIL-B-121
6	Transparent, watervaporproof, waterproof, greaseproof, barrier type I.	MIL-B-22191
7	Transparent, waterproof, greaseproof, barrier type II	MIL-B-22191
8	Transparent, waterproot, barrier type III	MIL-B-22191
9	Watervaporproof, greaseproof barrier, class 1	MIL-B-131
10	Transparent, waterproof barrier, 4 mils thick, noncorrosive	L-P-378

A-3. Usage

Using the wrong barrier or wrapping material may result in damage to the packed item because of inadequate protection. Using an expensive material where a cheaper material would provide the required protection results in increased packing costs. Personnel doing military packaging should become familiar with the ten basic materials specified herein and with their proper selection and use in accordance with the instructions provided in this technical order.

A-4. Electrostatic-Free and Transparent Barriers

Transparent or electrostatic-free barriers are required for some packing applications. For such applications, the barrier material will be specified. The following table lists materials with electrostatic-free or transparent properties along with other properties common to other barrier materials.

Table A-2. Electrostatic-Free and Transparent Barriers

Material	Barrier properties	Transparent	Electrostatic-free
L-P-378, type I	Waterproof	Yes	No
MIL-B-22191, type III	Waterproof	Yes	No
MIL-B-22191, type II	Greaseproof, waterproof	Yes	No
MIL-B-22191, type I	Watervaporproof, greaseproof, waterproof	Yes	No
MIL-B-22019	Volatile corrosion inhibited.	Yes	No
MIL-B-81705, type I	Watervaporproof, greaseproof, waterproof	No	Yes
MIL-B-81705, type II	Watervaporproof, waterproof	Yes	Yes

NOTE

Only type I of MIL-B-81705 is greaseproof. Type II of MIL-B-81705 should not be used when oil or grease resistance is required.

NOTE

Where flame resistance is required, material conforming to MIL-B-81916 must be used.

A-5. Cost

The cost per square yard of wrapping and barrier materials covers a wide range. Cost of various materials will vary with time and supplies. Table A-3 lists the approximate comparative costs of the ten specified materials as well as suggested alternate materials. Material 1 in the table is assigned the arbitrary cost index of 1. Each of the other materials will be more expensive than material 1 by a factor equivalent to its cost index. *For example*, material 5 with a cost index of 8 will be 8 times more expensive than material 1 and 4 times more expensive than material 3. It is apparent from the table that it is essential to use the least expensive barrier or wrapping material wherever they will serve the purpose if packaging costs are to be maintained at a minimum.

Table A-3. Comparative Costs of Barrier and Wrapping Materials

Material	Cost index
1	1.0
2	1.5
3	2.0
4	3.5
5	8.0
6	102.0
7	10.0
8	2.5
9	9.0
10	11.0

A-6. Other Flexible Barriers and Wrapping Materials

Because suitable new flexible barriers and wrapping materials may be developed and because prices of competing materials may change, materials other than those specified may qualify for use. When other barriers or wrapping materials exhibiting properties equal to or better than those of the prescribed materials or suggested alternates become available at the same or lower cost, such new materials may be used in lieu of the prescribed or alternate materials.

APPENDIX B
NATIONAL STOCK NUMBERS

B-1. General

a. The selection of the proper items of supply for use in military packaging operations is of vital importance. This selection must be made in accordance with requirements established in commodity and process specifications and other official publications. Items of supply are designated by name, type, class style, grade, size, color, length, width, etc. The difference of an item in any of these respects from any other item, establishes it as a separate and distinct item of supply. To properly perform preservation and packing processes, methods, and procedures, these distinct items must be used as specified. To make proper selection possible, the Federal Catalog System is designed to classify, describe and assign one, and only one, National stock number to each item of supply. The listing of classifications, descriptions and National stock numbers for the hundreds of items used in packaging and packing and appearing in the Federal Supply Catalogs is beyond the scope of this manual. The purpose of this appendix is to emphasize the importance of stock numbers in the military supply system and to furnish general information concerning their structure and use.

b. The National Stock Number (NSN) is also called the NATO stock Number, as it is used by all NATO countries and indicates the country of origin. *For example,* 00 or 01 in the *5th* and *6th* positions indicates US material. Other countries are 23, 25 etc.

B-2. Composition of the National Stock Number

The National stock number (NSN) is composed uniformly of 13 digits and is always written in a 4-2-3-4 format with a dash after the fourth, sixth, and ninth digits to facilitate readings e.g. 8105-00-290-0345. The first four digits (8105) are the *Federal Supply Classification Code (FSC),* and the last nine digits (00-290-0345) are the National item identification number (NIIN). The whole National stock number is never separated to run into a second line.

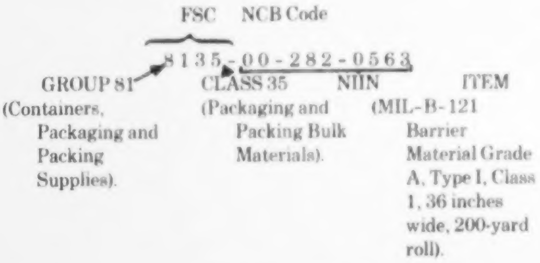
a. Federal Supply Classification. The Federal Supply Classification is used to classify items of supply identified in the Federal Catalog System. It is designed to include all items known to be in the supply system of the Federal Government. Of the four-digit code (8105) used to identify Federal supply classifications, the first two digits identify the broad *Group* of material. Group 81 covers containers, packaging, and packing supplies, and the last two digits identify a particular *Class* within the Group. Class 05 covers bags and sacks. Other examples of Federal Supply Classifications are as follows:

FSC	*Group*	*Class*
5530	55 (Lumber, Millwork, Plywood, and Veneer).	30 (Plywood and Veneer)
9150	91 (Fuels, Lubricants, Oils, and Waxes).	50 (Cutting, Lubricating, and Hydraulic Oils and Greases).

b. National Item Identification Number. The last nine digits of the National stock number comprise the National *item identification number.* This number serves to differentiate each item of supply from all others within its *Class.* In the example above, the NIIN 00-290-0345 identified a 9½-inch x 14½-inch paper cushioned shipping sack, conforming to Specification PPP-S-30, from all other bags and sacks in the 05 *Class.* Each item of supply has one, and only one, National Stock Number. The National item identification numbers are assigned serially without regard to the name of the item, its description, or its classification. The National Codification Bureau (NCB) Code is represented by the first two digits in the NIIN.

B-3. Breakdown of the National Stock Number

For clarification purposes the following is a breakdown of another National stock number related to a common packaging material:


FSC
NCB Code
8135-00-282-0563
GROUP 81
(Containers, Packaging and Packing Supplies).
CLASS 35
(Packaging and Packing Bulk Materials).
NIIN
ITEM
(MIL-B-121 Barrier Material Grade A, Type I, Class 1, 36 inches wide, 200-yard roll).

B-4. Use of National Stock Numbers

Items of supply for use in preservation and packing operations are of wide range and appear under several group and class codes. These codes cover cleaning materials, preservatives, barriers, tapes, adhesives, cushioning materials, various types of equipment, marking materials, fasteners, interior containers, exterior containers, and many other groups and classes. Oftentimes, there are several classifications covering general groups of items. National stock numbers are assigned to each specific item under each classification in accordance with item name and specific characteristics. When selecting items and materials which meet the requirements of packaging and packing specifications and directives, identification is accomplished by reference to titles and descriptions appearing in the Federal Supply Catalog. The following are representative examples:

National stock No.	*Description*
8135-00-171-0930	*Barrier Material, Greaseproof, Flexible:* smooth; heavy duty type; moldable and self-adhering, w/self-adhering coating applied on both sides; 100 yd. roll, 48 in. wide; Specification MIL-B-121, Grade C, Type I.
8135-00-558-0823	*Cushioning Material, Packaging:* cellulose wadding; water-resistant; low absorbency; 66 ft. long, 20 in. wide, 1 in. thick; Specification PPP-C-843, Type II, Class B.

B-5. Sources of National Stock Numbers

a. National stock numbers are listed in Federal Supply Catalogs published by the Defense Supply Agency. Stores Stock Catalogs published by General Services Administration contain numbers and descriptions of items handled by this agency. Federal and Military commodity specifications indicate federal supply classification codes only.

b. The quantity of NIIN's is about to be used up and a new series of numbers will go into use. These will use 01 as the first 2 digits for the NIIN. An example of a new NSN is as follows:

NSN 2920-01-293-4380

When you see the new 13-digit NSN you will know it is a former FSN if it has 00 after the first 4 digits. It is a new NSN if it has 01 there.

Example:

NSN 5820-00-156-4519 (Former FSN)
NSN 5820-01-156-4519 (New Item)

BY ORDER OF THE DIRECTOR, DEFENSE LOGISTICS AGENCY

R. F. McCORMACK
Colonel, USA
Staff Director, Administration, DLA

By Order of the Secretaries of the Army, the Navy, and the Air Force:

E. C. MEYER
General, United States Army
Chief of Staff

Official:
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Brigadier General, United States Army
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